



**PHD**

**Exploring alternatives to rational choice in models of Behaviour**  
**An investigation using travel mode choice**

Thomas, Greg

*Award date:*  
2014

*Awarding institution:*  
University of Bath

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# **Exploring alternatives to rational choice in models of behaviour: An investigation using travel mode choice**

Gregory Owen Thomas

A thesis submitted for the degree of Doctor of Philosophy

University of Bath

Department of Psychology

March 2014

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## **Acknowledgements**

First and foremost I would like to thank my supervisor, Dr Ian Walker, for his constant and enthusiastic support, patience when correcting my grammar, and giving me the inspiration to make this thesis happen.

I am deeply grateful to Martyn Whalley, Director of Estates for the University of Bath, for his generous funding that granted me the opportunity to undertake this research. I would also like to thank my second supervisor, Prof Bas Verplanken, for his assistance and guidance.

To all those who gave their time to take part in this research, you have my sincerest thanks.

I'd like to thank Dave for his friendship and his outstanding generosity, and also the 5 South team: Hannah, Laurie, and James, for making the last three years so much fun.

This thesis would not have been possible without the love and support from my parents, and to my brother Phil, for keeping me smiling throughout it all.

Finally, I would like to thank Gemma for her love and encouragement, the care packages that kept me going, and for never losing faith in me.





## **Description of work submitted for publication**

An adaptation of the work described in Chapter 3 has been accepted for publication as:

Thomas, G. O, Walker, I., and Musselwhite, C. (2014) “Grounded Theory analysis of commuters discussing a workplace carbon-reduction target: Autonomy, satisfaction, and willingness to change behaviour in drivers, pedestrians, bicyclists, motorcyclists and bus users.” *Transportation Research Part F, Vol 26, 72-81.*

An adaptation of the work described in Chapter 4 has been submitted for publication as:

Thomas, G. O. & Walker, I. (in press) “Users of different travel modes differ in satisfaction and habit strength but not environmental concern: A large-scale survey of drivers, walkers, bicyclists and bus users commuting to the same location” *Transportation Research Part F.*

An adaptation of the work described in Chapter 6 has been submitted for publication as:

Thomas, G. O. & Walker, I. (in press) “Development and Validation of a Measure of Implicit Environmental Values: An application of Egoistic and Biospheric value orientations” *Environment and Behavior*

An adaptation of the work described in Chapter 7 has been submitted for publication as:

Thomas, G. O. & Walker, I. (manuscript submitted) “Can’t see the route for the trees: A new exploration-based method of investigating routine influences on a path-finding task” *Journal of Behavioral Decision Making*



## **Thesis Abstract**

The car is the most popular travel mode in the UK, but reliance on the car has numerous negative effects on health, the economy, and the environment. Encouraging sustainable travel mode choices (modal choice) can minimise these problems. To promote behaviour change, psychologists have an interest in understanding modal choice. Historically, modal choice has been understood as a reasoned and rational decision that requires a conscious assessment of thoughts and attitudes: but evidence suggests this approach has limitations when promoting behaviour change. Alternatively, processes that are automatically enacted, without conscious effort, can have an influence on thought and behaviour. Two automatic processes in particular have been proposed as useful factors when considering modal choice: habit and affect. Habits are behaviours that are learned over time in stable contexts, have become automatic, and moderate the link between intentions and behaviour. Affect is an automatically positive or negative sensation, which can influence consciously accessed attitudes and perceptions. This thesis explores these two automatic concepts in travel mode choice, with the aim of applying the concepts to promote sustainable travel. Using a mixed-methods approach, initial exploratory work used qualitative and quantitative methods to define how people construct affective responses to modal choice, and whether certain travel modes are more automatic than others. The exploratory work inspired three investigations: modelling the influence of automatic and reasoned decisions to use a travel mode, measuring automatic and implicit environmental preferences, and illustrating how changing the context of routines can increase use of available information. Exploratory and investigative results are then applied in the creation of the UK's first Walking Network, a series of walking routes designed to deliver targeted information and knowledge to promote walking. This thesis concludes that automatic influences are beneficial factors when considering modal change interventions.



## Chapter 1: Introduction

Traffic and transport psychology holds a vast breadth of topics: from accident analysis to spatial planning, behaviour change programs to psychoacoustics, from emission calculations to quality of life and social mobility. The field examines how our movements affect us at the physical, mental, societal, and environmental levels. As an applied branch of psychology, transport psychology uses quantitative and qualitative methods, with theory and methods determined from cognitive, social, environmental, health, and many other disciplines to explore the vast range of implications of travel mode choice. In particular, I have chosen to focus on how people make their travel mode choice, and whether sustainable alternative modes can be promoted.

Private car use is the most frequent mode of travel in the UK; in 2012, 64% of journeys were taken by car, which accounts for 78% of the total distance travelled by UK residents (DfT, 2013a). Recent figures show a slight decrease in private car use (DfT, 2013b), the first instance since records began; but it remains to be seen whether this is a trend that reflects a widespread modal change, or a temporary reaction to the recent economic crises<sup>1</sup>. Nonetheless, with 643 billion kilometres travelled by motor traffic in 2012 (DfT, 2013b), car and motor use remains a serious concern for several areas. Congestion on UK roads is estimated to cause somewhere in the region of £7 billion pounds a year in wastage and production disruption (Eddington, 2006), and costs are predicted to rise to around £22 billion by the year 2025 (House of Commons, 2011). Considering health and well-being, increased car use is linked to higher stress (Wener & Evans, 2011), with an associated lack of physical activity associated with rising levels of obesity (Frank, Andresen, & Schmid, 2004; Jacobson, King, & Yuan, 2011; Wen, Orr, Millett, & Rissel, 2006). Indeed low levels of physical activity are a stronger predictor of premature death than smoking (Blair, 2009). Car and transport emissions have been linked to a variety of respiratory diseases, including child asthma (Gehring et al., 2010) and increased mortality rates in adults (Knox, 2008), with emission reduction programs projected to increase life expectancies and lower heart disease (Woodcock et al., 2009). Emissions from cars also presents a wider challenge to Climate Change and Global Warming: second only to electricity production, transportation was responsible for emitting 121 million tonnes of CO<sub>2</sub> in 2010 (DECC, 2014), and cars and taxis were responsible for the majority of transport emissions (DfT, 2011). For comparison, the

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<sup>1</sup> In brief, an unsustainable rise in credit and asset price inflation from the early 1990's (FSA, 2009) led to financial institutions becoming increasingly vulnerable to market changes, and triggered by a collapse of the US sub-prime mortgage market in 2008 (European Commission, 2009) financial institutions such as the US investment bank Lehman Brothers defaulted causing stock markets worldwide to fall. The resulting fallout from the crisis directly affected the British economy with increasing unemployment and lowering household income (ONS, 2011).

effect of road transport emissions, due to greater distance travelled and effects of long term emission particles, is estimated to be around four times more harmful to global temperature than emissions from aviation or shipping (Berntsen & Fuglestedt, 2008). Even with the slight reduction of car use seen recently, cumulative CO<sub>2</sub> levels require a stronger commitment to reduction to avoid the “trillionth tonne” problem<sup>2</sup> (Allen et al., 2009). The problem of climate change has been recognised by the British Government, who have published a ‘Carbon Plan’ outlining measures to reduce emissions from several areas, including transport, citing climate change as “one of the greatest threats to both UK and global security and prosperity” (HM Government, 2011, p. 5).

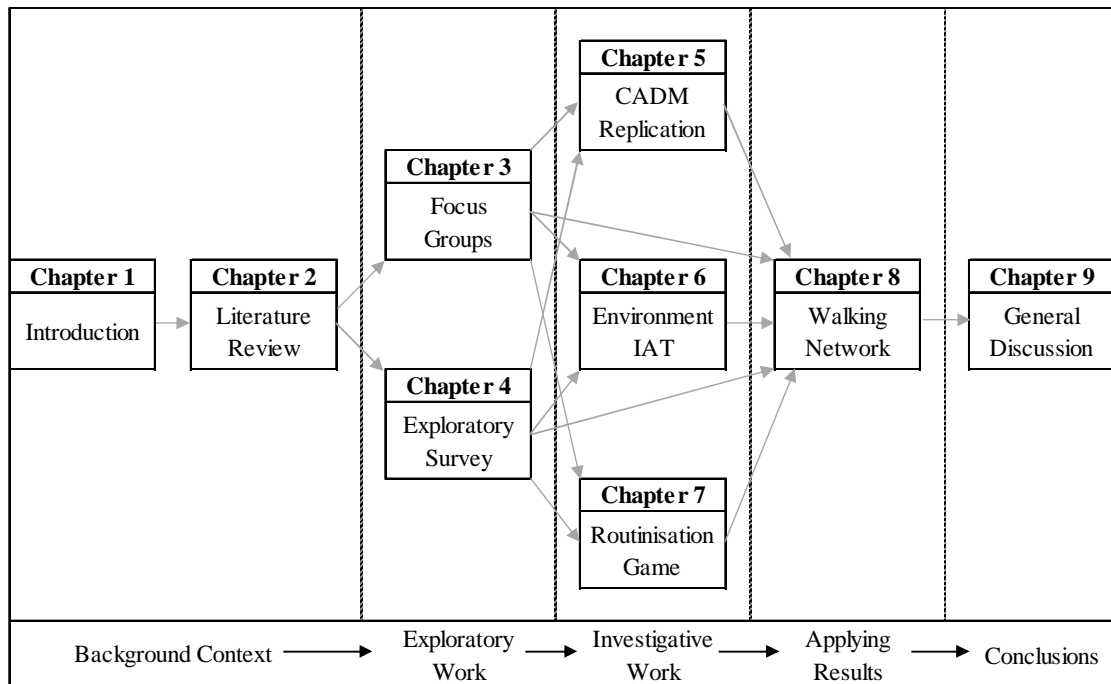
The University of Bath is also committed to reducing carbon emissions, and this PhD was funded on the proviso that I undertake the role of an internal consultant for the Department of Estates. The role required investigation into how to promote sustainable travel to the university campus, in order to comply with the target of reducing university carbon emissions by 43% by the year 2020, as set out by the Higher Education Council for England (HEFCE). The main requirement of the PhD funding consisted of designing, running, analysing, and reporting the results of the biennial university travel survey. The survey includes all staff and students based at the university, and measures views on transport issues and carbon reduction methods. This opportunity not only granted the chance to collect data from these large-scale surveys, but also to implement the results of my research to promote sustainable travel at the University of Bath.

### **1.1 The Structure of this Thesis**

The general structure of this thesis consists of nine chapters (including this brief introduction), divided into five sections that reflect different research foci throughout my PhD. The general structure can be best shown in Figure 1.

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<sup>2</sup> Referring to the need to keep total carbon emissions, including levels already present and previously emitted, less than 3 trillion tonnes to avoid raising global temperatures by 2°C to meet targets set by the Copenhagen Accord in 2009.



**Figure 1: Outline schematic of this thesis, illustrating how each chapter reflects a research area, and links between each chapter.**

Each of the four sections represents a general chronological progression throughout my research, and their cumulative influence on the final application of my research.

### 1.1.1 Background Context

The first section provides some background information to define the topic of this thesis. Chapter 1 discusses the motivation behind the research topic of transport mode choice<sup>3</sup>, and gives a brief overview and illustration of how the thesis is structured. Chapter 2 reviews the current literature of travel mode choice, defining the key concepts discussed in this work, and highlighting the research area that I hope to address. The aim of this section is to give the reader a full sense of what this thesis is attempting to accomplish, and the reasons why this research is being undertaken.

### 1.1.2 Exploratory Work

The second section describes two different approaches to explore new ideas and concepts identified in the literature review. Chapter 3 reports a qualitative investigation using a focus group design, and Chapter 4 describes the quantitative approach that utilised the first university travel survey undertaken in May 2011. The two chapters are complimentary: each represents an attempt to explore topics within their different epistemological approaches. This section provides an observation of modal choice issues, that serves as the backbone to the research questions addressed in the third section, and these studies are referred to throughout

<sup>3</sup> Henceforth known as “modal choice”



this thesis. Additionally, quotes taken from the Chapter 3 Focus Groups are displayed throughout this Thesis to illustrate the basis of each chapter, and to show how research questions developed from this exploratory work.

### **1.1.3 Investigative Work**

With a more concrete idea of some of the issues and results from the exploratory work, this third section highlights specific enquiries into research areas. Chapter 5 is an attempt to replicate a complex model predicting the motives for environmental behaviour, using data from the second university travel survey undertaken in November 2012. Chapter 6 describes the creation of an implicit measure of environmental concern, to compare implicit and explicit attitudes between travel mode user groups. Chapter 7 discusses the creation of a new interactive method of route-finding problem solving, and how repetition and preferred travel mode choice can influence route-choice selection. The aim of this section is to demonstrate, through a mixture of experimental and modelling methods, some of the complexity of travel mode choice, and alternatives to rational choice model concepts.

### **1.1.4 Applying Results and Conclusions**

With a mix of methodologies and research aims, the fourth and fifth sections integrate the wide mix of investigations in two different ways. Chapter 8 describes how each study provided some evidence and consideration to create the ‘Walking Network’: a series of accessible walking routes to encourage healthy and sustainable transport. Chapter 9 is a more conventional summary of the findings, conclusions, and challenges faced during the course of this research. The aim of this section is to provide closure, with a summary of the practical and theoretical applications of my research into travel mode choice.

## **1.2 A Note on Methodology**

Transport psychology is an incredibly diverse field, employing a range of different methodologies, and understanding modal choice can be a surprisingly complex issue (De Witte, Hollevoet, Dobruszkes, Hubert, & Macharis, 2013). My research aim is to highlight alternative psychological motivations and influences on travel mode choice, rather than the conventional use of rational choice models (described in more detail in Chapter 2). Given the complexity of the field and subject topic, a range of different methodologies are helpful when illustrating how alternatives to rational choice constructs may exist when discussing travel mode choice.

At a fundamental level, the two main research approaches in psychological research are quantitative (statistical and experimental analyses) and qualitative (discursive and experiential analyses). The divide between advocates of these epistemological camps is highly contentious; Stainton Rogers (2011, p. 7) colourfully describes the disagreement as a

“metaphysical battle” between the younger “David” (generally qualitative) and the established “Goliath” (generally quantitative). Despite such extreme views, there is a large amount of support from theorists and researchers to combine qualitative and quantitative approaches towards a third paradigm: mixed methods research (Denzin, 2008; Johnson, Onwuegbuzie, & Turner, 2007; Teddlie & Tashakkori, 2010). Mixed-methods is a *pragmatic* approach to research that rejects the dogmatism and dualism of established theories, and instead strives towards a moderate and sensible view of social science (Johnson & Onwuegbuzie, 2004). A key benefit of mixed methods is the range of approaches that work together to create a deeper understanding of a topic. Combining qualitative and quantitative approaches allows *triangulation*: different approaches illustrate the full complexity of a research question that singular approaches may ignore or mischaracterise (Lieber & Weisner, 2010). The process of mixed methods is often cyclical and iterative, and best summarised by Teddlie & Tashakkori (2010):

*“The cycle of research may be seen as moving from grounded results (facts, observations) through inductive logic to general inferences (abstract generalizations or theory), then from those general inferences (or theory) through deductive logic to tentative hypotheses or predictions of particular events/outcomes” (p. 10)*

This cyclical approach is employed within this thesis; the opening investigations employ qualitative and quantitative methods, which then form tentative hypotheses that are investigated using empirical and experimental approaches to form hypotheses; these concepts are then applied when attempting to change behaviour. Moving from exploratory qualitative work to more confirmatory (and traditionally quantitative work) is sometimes termed a *parallel* mixed design, with the two forms of research occurring concurrently while both sets are considered in final conclusions (Tashakkori & Teddlie, 2009).

To select the most appropriate methodology for a research question, a researcher may work from a “top-down” approach where prior theoretical positions (e.g. anti-discriminatory or participatory research) guides the selection of methods (Johnson et al., 2007). The alternative is “bottom-up” selection of research methods that best suit the research in question: a position chosen in this thesis. By selecting methodologies that suit individual questions, not only does this allow the most appropriate method to be applied, it also facilitates the researcher to become a “connoisseur of methods” to investigate and ensure the best methods are applied (Teddlie & Tashakkori, 2010, p. 8). Using a bottom-up orientation, this thesis has a complex mixture of methods: Grounded Theory, Survey Analysis, Structural Equation Modelling, Implicit Association Tests, Cognitive puzzle tasks, and Action Research. Each approach requires a considerable amount of discussion on the methodology employed,

and often the methodologies tie to the analysis and results. For example, when conducting Structural Equation Modelling in Chapter 5, methodological discussions deeply influence the interpretation of results. Additionally, the theoretical understanding of Grounded Theory methods in Chapter 3 is a vastly different topic to the theoretical understanding of the Implicit Association Task discussed in Chapter 6. Given the range of methods, this thesis does not contain a methodology chapter, but will discuss methodology for each chapter where appropriate.

### **1.3 Conclusions**

This brief introduction serves three purposes. First, I hope to outline the motivation behind the study of promoting sustainable and healthy travel mode choices as a topic with large societal outcomes. Second, this chapter illustrates how a collection of various studies is organised into a coherent Thesis that explores issues surrounding sustainable travel mode choice. Third, I hope to have made clear my justification for employing a mixed-methods approach that allows me to explore, investigate, and apply my findings.

## Chapter 2: Literature Review

### 2.1 Abstract

*In preparation for this thesis, and to give context to the topics investigated, a review of the relevant literature was compiled. Using previous knowledge of the topic, advice and suggestions from experts in the field, and extensive searches using on-line literature search engines, this chapter highlights important work that frames the background and scope of my research. The review focuses on previous understanding of how travel mode choice has been explained through three conceptual views. Firstly a review of the rational, expectancy-value models is presented, focusing on the popular Theory of Reasoned Action and Theory of Planned Behaviour models. Then the review covers the historical development of habitual behaviour, and the moderating effect of habit on intention, drawing attention to the non-rational influence on behaviour. Thirdly, a review of the affective and symbolic factors relating to influences on cognition and travel mode choice is presented. These concepts are discussed in the context of dual-process models of cognition before identifying gaps in the research and the topics to be investigated in this thesis.*

### 2.2 Introduction

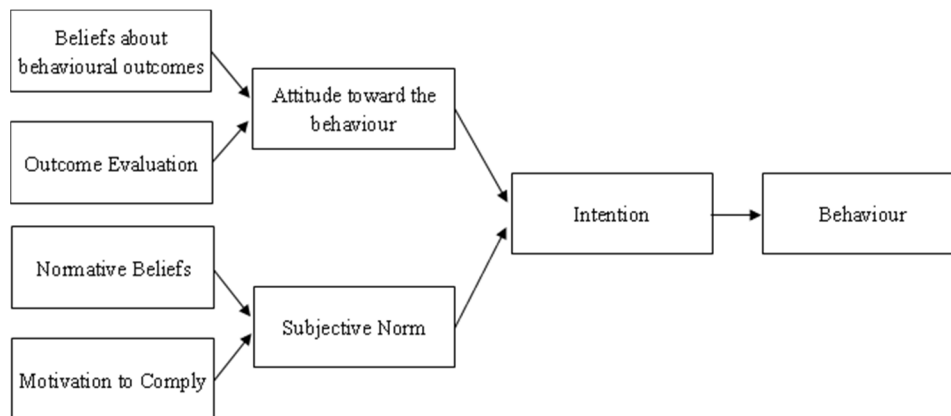
The purpose of this literature review is to encapsulate the area I wish to explore within this thesis – how we choose to travel, and how our rational and conscious decisions may contrast with automatic and uncontrolled processes. This review is split into four sections that give context to the key theoretical considerations covered within this work. First, rational-choice models are introduced and discussing as the traditional view of explaining behaviour through a reasoned approach. Second, the topic of habit is introduced, discussing how learned automaticity of behaviour contrasts with conventional models. Third, affect-based responses to travel are then discussed, defined as the automatic positive or negative valence felt when considering a travel mode, and how affect may conflict with reasoned-behaviour approaches. Lastly, the automaticity of habit and affect, in contrast to reasoned approaches, are briefly discussed under the conceptual umbrella of Dual Process theories. Noting an emerging interest in automatic processes to explain behaviour, and the increasing support for investigating habitual and affect-based influences, this review sets out the rationale for the topic of this thesis.

### 2.3 Rational Choice Models

When discussing ‘rational choice’ models, I am referring to explanatory models of behaviour that use consciously accessed attitudes and beliefs to rationalise an intention to enact a behaviour. Such models view this consideration of attitudes and beliefs as a fundamental requirement, as they form the intention towards a behaviour, which leads to the behaviour

being undertaken. These models are also called *deliberative* (Perugini & Bagozzi, 2004) or *expectancy-value* (Feather, 1982) models: behaviour stems from an individual's expectation of a behaviour outcome, and the individual's subjective value of the action's consequences. By understanding the attitudes towards a behaviour, proponents of these theories state that it will be possible to predict the behaviour accordingly. The view of these rational choice models is best summarised by Fishbein and Ajzen (1975): “*Generally speaking, we view humans as rational animals who systematically utilize or process the information available to them*” (p. iv).

One of the early expectancy-value models developed was the Theory of Reasoned Action (Fishbein & Ajzen, 1975). A schematic of The Theory of Reasoned Action is presented in Figure 2 below.



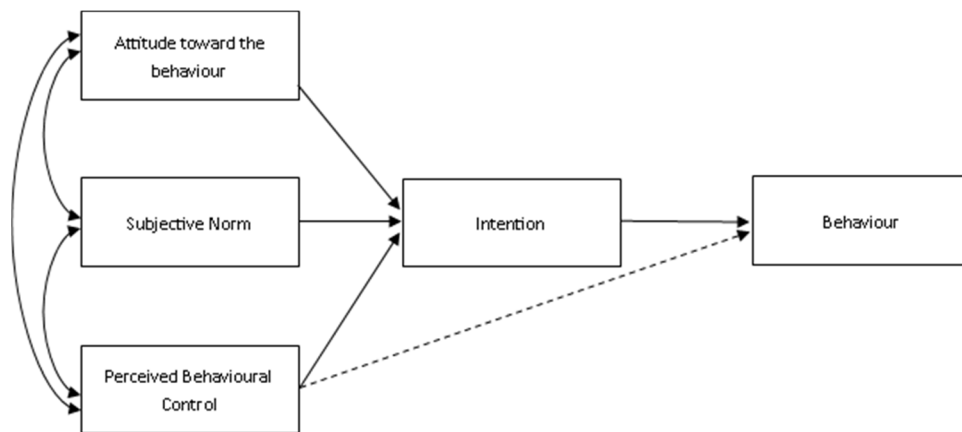
**Figure 2: Illustrated conceptual framework of the Theory of Reasoned Action. Adapted from ‘Belief, Attitude, Intention, and Behavior: An introduction to Theory and Research’ by Fishbein, M. and Ajzen, I. (1975, p. 334) Copyright by Addison-Wesley Publishing Company**

The theory states that an intention to perform a behaviour is the direct cause of the behaviour, and is a conscious decision to carry out that action (Bohner & Wänke, 2002). The intention to perform a behaviour is mediated by two constructs: attitudes and subjective norms. Here, attitude reflects an individual's views on a behaviour as *expecting* either a good or bad outcome, and the *value* that the consequence of the behaviour will bring. The model states that an individual calculates their attitude by multiplying the expectancy probability and subjective value for each consequence of an action, and using their total sum value (Maio & Haddock, 2010). For example, a person may wish to give up smoking to improve their health (high probability and high value), but may have to endure cravings and withdrawal (high probability and low value), and combining these would lead to a moderated view of quitting smoking. Attitude is measured using Likert scales (Likert, 1932) by directly measuring attitudes toward the behaviour, or by multiplying measured a person's beliefs about outcomes and their outcome evaluations.

The second component, subjective norm, is likewise the total product of multiplying two antecedents. The first is *normative beliefs*: how people important to the individual would expect them to act, and secondly the *motivation* of the individual to adhere to these expectations. For example, if a person's family and friends approve of quitting smoking, and the individual desires the approval of peers, then subjective norm is strong and supports the intention to quit smoking. Measurement employs Likert scales to measure a person's general subjective norms around the behaviour, or multiplying questions on normative beliefs of the behaviour and also their motivation to comply.

The Theory of Reasoned Action has been used in a wide range of fields from health decisions, consumer behaviours and important life decisions (Bohner & Wänke, 2002). Meta-analytic reviews of the theory's effectiveness in predicting behaviour from intention varies however. A review of 87 studies of various behaviours found that intentions explained 28% of variance in behaviour (Sheppard, Jon, & Warshaw, 1988), intentions explained 20% of the variance in 96 studies of condom use behaviour (Albarracín, Johnson, Fishbein, & Muellerleile, 2001), and further estimates of behaviour variance explained in meta-analyses ranges from 19% to 38% (Sutton, 1998). These meta-analyses indicate that there remains a sizable portion of variance in behaviour not explained. The theory may be limited in its scope: factors outside of the theory such as demographics, personality, past behaviour and other attitudes are not considered, but seen as indirect and minimal influences on behaviour (Bohner & Wänke, 2002). Additionally, there have been criticisms that the theory is limited to behaviours that are easily accessible and available, and does not account for the skills, knowledge, or resources to enact others behaviours (Conner & Armitage, 1998; Sheppard et al., 1988).

To address such concerns, a revised version of the theory was presented by Ajzen (1985, 1991) called the Theory of Planned Behaviour (TPB), which is illustrated in Figure 3 below.



**Figure 3: Illustrated conceptual framework of the Theory of Planned Behaviour. Adapted from ‘The Theory of Planned Behavior’ by Ajzen, I., 1991, *Organizational Behavior and Human Decision Processes*, 50 (2) p. 182. Copyright by Elsevier Publishing.**

The TPB adds an additional dimension to the model called *perceived behavioural control*, while retaining (though renaming) the previous factors of attitude and social norm<sup>4</sup>. This new construct relates to an individual’s ability to perform a behaviour, and is seen as an application of Bandura’s self-efficacy theory (1977, 1982), placing it within a more comprehensive framework that includes behaviour, intention, and attitudes (Ajzen, 1991). Perceived behavioural control has two effects on aspects of the theory: it directly influences intention to perform a behaviour since it reflects confidence to enact the behaviour (Maio & Haddock, 2010); and secondly, it directly influences behaviour by acting as a ‘check’ whether the behaviour could practically be performed (Bohner & Wänke, 2002). Returning to the example of someone quitting smoking, a person may physically be able to give up their habit, but if they do not feel they have the ability (e.g., willpower or knowledge), then their intention is reduced, despite their positive attitudes. PBC is measured using the same method as attitudes and subjective norms, a Likert scale for participants to indicate their ability (e.g. *I believe I can perform the behaviour: Agree/Disagree*) and autonomy (e.g. *I can choose to perform the behaviour: Agree/Disagree*).

### 2.3.1 Evaluating the Theory of Planned Behaviour

The Theory of Reasoned Action and the TPB became the most common models within attitude-behaviour research (Maio & Haddock, 2010), with the TPB taking predominant place in the field of travel mode choice (Anable, 2005; Gardner & Abraham, 2008; Jakobsson Bergstad, 2007). The addition of perceived behavioural control was thought to improve the predictive utility of the model for complex behaviours requiring planning or consideration (Bohner & Wänke, 2002), supported by a meta-analysis suggesting that PBC improves

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<sup>4</sup> Additional feedback from behaviour to antecedents is still present, but not shown in Figure 3 for clarity, as suggested by Ajzen (1991)

predictions of behaviour when measuring an overall assessment of an individual's feeling of control over an action (Notani, 1998). For more general performance, and as an indicator of the popularity of the model, the TPB has been subject to range of meta-analytical reviews. A comparison of various behaviours across 185 studies found that the TPB explained 27% of variance in behaviour, with the PBC construct explaining an additional 5% of variance for intention, and 2% of behaviour (Armitage & Conner, 2001). For more applied constructs, a review of physical activity behaviours found that intention predicted 44.5% of variance in behaviour (Hagger, Chatzisarantis, & Biddle, 2002). A meta-analysis of 76 health promotion behaviours indicated 34% of behaviour explained (Godin & Kok, 1996), with a more recent meta-analysis of 237 health-related studies predicting 23.9% of physical activity behaviour from intentions, but health risk behaviours (e.g. drugs and unsafe sex) had a predictive link of between 13.8%-15.3% (McEachan, Conner, Taylor, & Lawton, 2011). An alternative meta-analysis using experimental manipulations to determine the intention-behaviour link reported that medium-large changes in intention were linked to small-medium changes in behaviour (Webb & Sheeran, 2006). Finally, a meta-analysis of meta-analyses themselves (aggregating results from 82,107 participants) found 28% of variance in behaviour explained by intention (Sheeran, 2002).

Reviews of the effectiveness of the TPB in predicting behaviour have not finalised discussion of its value in attitude-behaviour research. As seen above, there is still a large amount of variation in behaviour unaccounted for; though some see the results as a positive step in prediction (Perugini & Bagozzi, 2004), others highlight the gaps that remain to be explained (Conner & Armitage, 1998). Though it has been argued that using variance explained as a measure of utility is an inherently pessimistic measure that downplays the value of a model (Sheeran, 2002), Ajzen's (1991) own discussion also highlights the fact that the TPB claims that behaviour is solely influenced by measured variables, and as such, they should explain a far higher proportion of behaviour.

The discussion of the TPB is given space in this review not just because of its wide application to general social-cognitive psychology (Ajzen & Fishbein, 2005), but it also remains one of the most popular models in exploring travel mode choice and guiding interventions (Gardner & Abraham, 2008; Loukopoulos, Jakobsson, Gärling, Schneider, & Fujii, 2005; Thøgersen, 2006). Several studies have used the TPB to explore travel mode choice by examining intention and its three antecedents. A meta-analytic review of studies using the TPB in travel mode choice (Gardner & Abraham, 2008) found that intention to use (or not use) a car was significantly linked to behaviour, explaining 28.1% of variance. Of the three antecedents, the meta-analysis highlighted perceived behavioural control (PBC) as the strongest correlate of both behaviour and intention, followed by personal attitudes, with



subjective norm proving an unreliable predictor of behaviour though linked to intention. Interestingly, all three predictors were stronger for non-car use than for actual car use, and general environmental attitudes (not directed towards car/non-car use) held a weak correlation with behaviours and intentions. These two factors will be discussed in more detail in section 2.4 of this review when highlighting research on habitual behaviour.

With 28.1% of intention-behaviour accounted for in car use (Gardner & Abraham, 2008), the TPB's application is comparable to reviews of other areas of behaviour (Sheeran, 2002). But, as previously mentioned, for a theory to explicitly regard factors excluded from the theory as minimal (Bohner & Wänke, 2002), the TPB may have to reconsider additional factors to improve the model. Originally, Ajzen (1991) saw the TPB as open to additional factors if they captured a *“significant proportion of the variance in intention or behaviour after the theory's current variables have been taken into account”* (p.199), but two decades after its inception the TPB has remained unchanged. This is not to say that researchers have failed to add items of significant interest to the TPB. There are a number of calls for additional general factors to be added to the model, and proposed additions include (but not limited to): belief salience (Conner & Armitage, 1998), moral norms (Kaiser, 2006), personal norms (Bamberg, Hunecke, & Blöbaum, 2007), descriptive norms (Eriksson & Forward, 2011), anticipated regret (Kaiser, 2006), self-identity (Fielding, McDonald, & Louis, 2008), and affective response (Conner & Armitage, 1998). There is one particular addition, however, that has been proposed as an extension or supplement to the TPB has received considerable attention, in general use of the theory and for application in travel mode: habit and habitual behaviour (Ouellette & Wood, 1998).

## **2.4 Past and Habitual Behaviour**

Among the number of proposed additions to both the Theory of Reasoned Action and the TPB, theorists have suggested that the nature of past behaviour may influence behaviour outside of the antecedents presented (Bagozzi, 1981; Bentler & Speckhart, 1979). Past behaviour has been found to be strongly linked to future behaviour, and can improve predictive utility of the TPB when included as a unique factor (Conner & Armitage, 1998; Eagly & Chaiken, 1993). But the role of past behaviour in predicting future behaviour is unclear, since past behaviour must have stemmed from an original choice to enact a behaviour (Ajzen & Fishbein, 2005). Certainly, Ajzen (1991) highlighted the possibility of past behaviour's influence outside of the TPB, though noted concern over “common error variance” (p.202)<sup>5</sup> in measurement when comparing observed past behaviour and self-

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<sup>5</sup> Also known as common method variance, it refers to the potential for biased results created by using similar measurement methods, and participant's individual response strategies

reported scales. But, Ajzen (1991) argued that past behaviour could best be explained using the concept of PBC, since past experience would be the greatest predictor of one's ability to enact a behaviour, and that PBC would include the nature of experience within its construct.

With the popularity of the TPB, additional studies and research have examined whether past behaviour is a separate construct to the TPB, and whether it grants additional predictive utility to the model. Results from a meta-analysis of health behaviours (condom use) found past behaviour to add a small but significant benefit to predicting behaviour that was actually stronger than perceived behavioural control (Albarracín et al., 2001). In the context of predicting physical activity, a meta-analysis found that inclusion of past behaviour improved the intention-behaviour link, and was also a stronger predictor of behaviour than intentions (Hagger et al., 2002). An alternate meta-analysis (Ouellette & Wood, 1998) suggested that past behaviour held a large influence on behaviour independent of other TPB factors; but influence increased only for cases where a behaviour may become an automatic response in a stable context. This differentiation between behaviours that may become automatic was also recognised by Albarracín et al. (2001), who noted that their small influence of past behaviour was likely due to the largely irregular and changeable environment of their behaviour measure.

#### **2.4.1 The Automaticity of Habits**

There is a question, then, of what measurement of past behaviour actually characterises; whether past behaviour reflects a frequent action that influences intentions along TPB pathways to the same conclusion as before (Perugini & Bagozzi, 2004), or if past behaviour infers an automatic response outside of the consciously considered processes of the TPB (Conner & Armitage, 1998). The discussion from Ouellette and Wood's meta-analysis (1998) offers a response to this question by describing how past behaviour may influence behaviour in two ways. First, past behaviour may influence judgements where rational processing is required, in line with TPB and rational choice models. An example provided by Verplanken (2010) is the selection of an annual holiday location: a previous trip may have been a positive one, and this will influence a person's consideration of vacation destinations. Secondly, and moving away from the TPB's core concept, past behaviour may influence behaviour in contexts where past behaviour occurs frequently, in stable contexts, and where the behaviour requires minimal attention or control. For Ouellette and Wood (1998), the second description of past behaviour becoming an automatic behavioural response was best summarised as 'habitual' behaviour.

Work on the nature of habit as a determinant of behaviour is largely credited to the work of Triandis' (1977) Theory of Interpersonal Behaviour (Gardner & Abraham, 2008). Triandis (1977) described how a repeatedly performed behaviour, in order to meet a certain

objective, may no longer be driven by intention, but become an automatic response. The concept of automaticity is not new in psychology; several researchers (Bargh & Chartrand, 1999; Verplanken, Aarts, & Van Knippenberg, 1997) have highlighted references to the automaticity of behaviour from well over a hundred years of research, including notable figures such as William James (1918), Sigmund Freud (1901/2003) and John B. Watson (1914). Nonetheless, a re-emergence of automatic behaviours was developed building on work and theories developed by Triandis.

Bargh and Chartrand (1999) defined two types of automatic, or non-conscious, behaviours that are performed without effort or consideration: mental skills (that necessitate willpower to originally begin the behaviour) and preconscious processes (that do not require willpower to start). An example of a preconscious processes is the automatic assessment of stimuli, such as positive or negative faces, occurring quickly without intention, or possibly even awareness (Ferguson, 2007). Alternatively, habitual behaviours may be seen as ‘mental skills’ as defined by Bargh and Chartrand (1999); they require some initial consideration to originally enact the behaviour, but over time, may develop into a habitual behaviour. An example of an automatic mental skill used by Ouellette and Wood (1998) is using the telephone. As a child we may have used different hands and speaking styles, but over time, we do not need to consciously consider handedness or intonation when answering a telephone.

But for an actual description of what a habit actually is, one of the most widely-used definitions comes from Verplanken and Aarts (1999) who clarified the concept as:

*“Learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states.” (p.104).*

The definition from Verplanken and Aarts (1999) highlights key three concepts: learned acts, automatic responses, and specific cues. These three key components were later clarified as the three ‘pillars’ of habit (Verplanken & Tangelder, 2011). Of the three pillars, the first (learned acts) may better be described as repetition: habits are a form of repetitive thinking (Verplanken, 2012) or behaving (Gardner, 2009) that develop over time and continue through to future behaviour. But repetition alone is not sufficient for habitual behaviour. Secondly, habits are characterised by their automaticity: a concept composed of several factors including unawareness of the mental process, an automatic activation of the process, a means of quickly and efficiently using or acting on information, and a lack of control over some aspects of the mental process (Bargh, 1994). As an automatic concept, habits require little effort to enact and ease cognitive load to allocate resources more effectively (Aarts & Dijksterhuis, 2000). The third pillar of habit is that specific cues in environments may cue the habits into action

(Orbell & Verplanken, 2010), and behaviours that occur in the same location or time can become habitual (Ouellette & Wood, 1998; Wood & Neal, 2007). As an example, in a study of travel mode choice and environmental attitudes, participants who recently moved home and broke previous context cues acted more in line with their environmental beliefs, unlike those in static context whose behaviour was cued by context and not attitudes (Verplanken, Walker, Davis, & Jurasek, 2008).

Though the three pillars offer an accessible and broad definition of habits, Verplanken and Aarts' (1999) definition of habit (described above) includes an additional factor for consideration: "*functional in obtaining certain goals or end-states*". There has been some debate about the nature of goals within habits, with two main views: the *associationist* versus the *script-based* view (Friedrichsmeier, Matthies, & Klöckner, 2013). The associationists understand habit as dependent on context, but independent of goals to initiate the behaviour (Ouellette & Wood, 1998). Whereas the script-based view conceives habits as goal-dependent, but independent of context, so habits can be activated without the familiar context (Aarts & Dijksterhuis, 2000). LaRose (2010) describes how a conciliatory effort has been proposed to combine the views: "*Habits are a form of automaticity in responding that develops as people repeat actions in stable circumstances*" (Verplanken & Wood, 2006, p. 91). A more detailed theory by Wood and Neal (2007) describes how habits may originally be formed through repetitive goal-orientation, but through time, no longer require the goal activation, but are activated by the context the habit formed. The proposed theory describes a complex relationship between habits, goals, and intentions, that may all influence each other (Wood & Neal, 2007). Some work has begun to explore this question in more detail, with initial results supporting the associationist view (Friedrichsmeier et al., 2013), but as Verplanken (2010) notes, this debate is likely to continue.

#### **2.4.2 Measuring Habit**

The discussions of habit described above largely focus on the role of automaticity and repetition, which created a problem for researchers: how do you measure habit? One of the most common methods for researchers was to use self-reported frequency of past behaviour as a metric of habit strength (Verplanken & Orbell, 2003), with the reasoning that increased repetition led to a stronger habit (Ouellette & Wood, 1998; Triandis, 1977). However, and as pointed out by several researchers (Ajzen, 2002; Sheeran, 2002; Verplanken, 2006), equating past behaviour with habit strength creates several problems. Examples include nonsensical propositions such as our habit strength increasing every time we have a meal, or a doctor automatically advising a patient to a cardiologist if the previous 6 cases required a heart specialist (Verplanken, 2010). Clearly, a more valid measure of habit strength was required, especially a measure that captured the automaticity of habitual behaviour.

The first measure of habit, with the goal of capturing automaticity, was developed by Verplanken, Aarts, Van Knippenberg and Van Knippenberg (1994) and became known as the Response Frequency Measure (RFM). The RFM was designed so that participants had to choose between several options and were requested to give their choice as quickly as possible; in their paper, the authors used several travel destinations and participants had to quickly respond with their preferred travel mode. The RFM capitalises on mental schemas allowing quick activation of an answer, and more frequently cited responses are taken as an indication of stronger habit. An alternate measure of habit developed by Wood, Quinn and Kashy (2002) builds on the need for habit to occur in stable context (Ouellette & Wood, 1998). The measure focuses on context stability, frequency of behaviour, and automaticity; diaries were filled by participants every hour discussing their behaviours and thoughts at the time, and rated by independent assessors. This method of assessing habit from context stability and frequency has been successfully used in to differentiate habit from intention when contexts are stable (Danner, Aarts, & de Vries, 2008; Wood, Tam, & Witt, 2005).

In addition, Verplanken and Orbell (2003) developed the Self-Report Habit Index (SRHI), a 12-item survey scale based upon Bargh's (1994) four principles of automaticity (low awareness, low intention, mental efficiency and requiring effort to control) as well as history of repetition, and whether the behaviour is part of the individual's identity, reasoning that habitual behaviours are likely to reflect a person's life. The SRHI is designed to capture the automaticity of habitual behaviours, and experimental validation for the measure was presented in a comparison between the SRHI and implicit measures of attitudes for predicting behaviour. In a review of several measures, higher SRHI scores (indicating stronger habit) were linked to implicit (automatic) attitudes measures as better predictors of behaviour, while low SRHI were linked to explicit measures as stronger predictors (Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007). The SRHI has been successfully applied across various disciplines of health and consumer research (Verplanken, 2010), and is arguably the most popular measure of habit strength. The SRHI is not a flawless measure however; scholars have challenged the inclusion of the identity item: "*behaviour X is something that's typically me*" as unrelated to the construct of habit automaticity (Gardner, de Bruijn, & Lally, 2011a), and an item measuring the consequences of the habit: "*behaviour X is something that makes me feel weird if I don't do it*" which may be outside of awareness given the automaticity of habit (Snihotta & Pesseau, 2012). Also, the inclusion of SRHI items related to frequency of behaviour: "*behaviour X is something I do frequently*" may inflate the habit-behaviour link (Gardner, de Bruijn, & Lally, 2011b). Though re-assessment of studies within Gardner et al.'s (2011b) meta-analysis that excluded behaviour-related items in the SRHI

found no significant changes when accommodating for these items, the authors note the value of continuing evaluation of the scale.

The measure of habit strength is an important point in this review for two reasons. First, it separates the construct of habit from actual past behaviour. Detaching automatic, habitual constructs from behaviour allows evaluation of measures that may increase habit but not behaviour (Verplanken & Orbell, 2003). The SRHI provides a means to evaluate the formation of habit independently from behaviour frequency, shown by the increasing habit strength associated with different behaviours of the same frequency (Lally, van Jaarsveld, Potts, & Wardle, 2010). Secondly, the measurement of habit allows comparison with predictions of behaviour. Most notably it allows a comparison between reasoned behaviour and habitual behaviour. When discussing the formation of the TPB, Ajzen (1991) noted that

*“Only when habit is defined independently of (past) behaviour can it legitimately be added as an explanatory variable to the theory of planned behaviour.” (p.203).*

Evidence for separating habit from past behaviour has been provided in several studies using the SRHI (Gardner et al., 2011b; Orbell & Verplanken, 2010; Verplanken, 2006). Although the SRHI was been briefly mentioned as a developing measure of habit for comparison with reasoned action (Ajzen & Fishbein, 2005), neither Ajzen or Fishbein have made any statements or evaluation of the SRHI for inclusion within their rational-choice models.

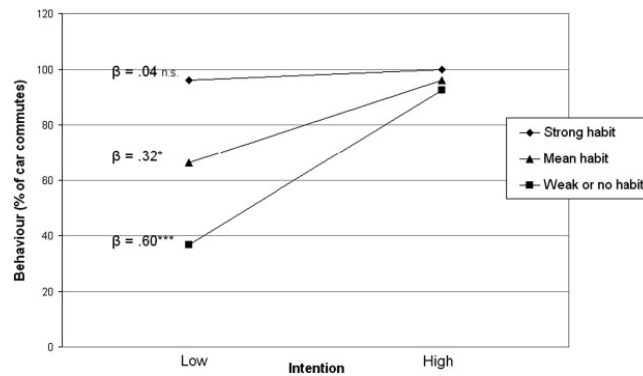
### **2.4.3 Habit and Intention**

The debate between automatic and externally-cued habitual influences on behaviour, and the TPB's focus on rational and considered actions, continues to this day. The role of automaticity in the TPB was recognised by Ajzen (2002), who noted that automatic responses to familiar stimuli were not incompatible with the TPB, arguing that once-reasoned approaches may be activated without conscious thinking, but these automatic processes would still be grounded in TPB factors to guide behaviour. Even with automatic processing in-line with the TPB, the main determinant of behaviour should still be intention. But with a history of studies that show past behaviour as a predictor of future behaviour, over the factors described within the TPB, it has been argued that these studies may suggest how past behaviour influences future behaviour (Ouellette & Wood, 1998). In their meta-analysis, Ouellette and Wood (1998) found that when behaviours were amenable to habituation (i.e., performed in a stable context), past behaviour was a stronger predictor than intentions, suggesting a possible link between habit moderating intentions.

More recent work using defined measures of habit, such the SRHI, has found further evidence of habit overriding intentions along the line of dual-process model proposed by Ouellette and Wood (1998). A meta-analysis of 47 intention-behaviour experiments found

that for habitual behaviours (using Ouellette and Wood's (1998) classification) habit strength strongly moderated intention and behaviour: the intention-behaviour relationship was considerably weaker in situations where habits were likely to form (Webb & Sheeran, 2006). Another meta-analysis of 9 studies using the SRHI on nutrition and physical activity (Gardner et al., 2011b) found that habit moderated the intention-behaviour link; that is, when habit increased, the link between intention on behaviour decreased. Other studies using a variation on Wood, Quinn and Kashy's (2002) habit measurement also indicated that strong habits overrode intention, and intention was predictive only when habits were weak (Danner et al., 2008; Ji & Wood, 2007). With a number of studies using varying measures of habit demonstrating the impact of strong habit over intention, predictions made by Triandis (1977) that strength of habit overrides intention for repetitive behaviours is a commendable insight. Several scholars now recognise that habit acts as a 'boundary' condition for rational choice models, such as the TPB, and combine the two approaches (de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009; van't Riet, Sijtsma, Dagevos, & de Bruijn, 2011; Verplanken & Aarts, 1999).

So could we argue that travel mode choice is habitual? Because of the repeated nature and stable context, several researchers have argued that travel mode easily lends itself to habitual behaviour (Aarts, Verplanken, & van Knippenberg, 1997; Gardner & Abraham, 2008; Wood & Neal, 2007; Wood et al., 2002). Some of the first work in habit used travel mode choice, and was used by Verplanken et al. (1994) in their development of the RFM measure of habit, who found several travel mode choices (e.g. car and bicycle) to be habitual, and supported by later work using the same measure supporting the dual-process model (Verplanken, Aarts, Van Knippenberg, & Moonen, 1998). A meta-analysis of psychological factors relating to car use (Gardner & Abraham, 2008) included 6 studies using TPB factors, and 5 studies using RFM measures of habit. Results from Gardner and Abraham's (2008) meta-analysis indicated that both intention and habit were strong predictors ( $r = .53$  and  $r = .50$  respectively), and endorsed both the TPB and habit as combined constructs in evaluating travel mode choice. Though Gardner and Abraham (2008) offer a useful direct comparison of predictors, further evaluation of travel mode habits, using the SRHI, have shown the interaction between habit and intention. Gardner (2009) highlighted how habit moderated intention, so that intention was predictive of car use behaviour only when habit was weak, shown in Figure 4.



**Figure 4: Illustration of habit moderating intention; where habit strength increases, intention to use a car is less predictive of actual behaviour. Adapted from “Modelling motivation and habit in stable travel mode contexts” by Gardner, B., 2009, *Transportation Research Part F: Traffic and Transport Psychology*, 12 (1), p.71. Copyright 2009 by Elsevier.**

Additional results from Møller and Thøgersen (2008) using both RFM and SRHI measures of car use habit found intention predicted behaviour only when habit strength was low (though noted the SRHI as a stronger moderator and potentially more reliable), and Ji and Wood (2007) using the frequency/stability method (Wood et al., 2002) also found habit to moderate intention for bus use.

Nevertheless, describing travel mode as a habitual behaviour is not a universally accepted premise. Using the argument that repeated behaviour is a sign of stable, reasoned intentions to use a travel mode, work by Bamberg, Ajzen and Schmidt (2003) investigated the effect of a travel intervention to promote bus use, and found little-to-no influence of habit but supported TPB variables. However, this study, taken in two waves, used a self-report measure of past behaviour as a proxy for habit in the first wave, which is known not to be indicative of habit (Ajzen, 2002; Verplanken, 2006), and compared with the RFM measure taken in the second wave. Additional intervention studies of free bus tickets (Bamberg, Rölle, & Weber, 2003) and a context change intervention (Bamberg, 2006) comparing the RFM measure of habit against the TPB also found habit to be an non-significant predictor of increasing public transport. In opposition to these findings, another study (Bamberg & Schmidt, 2003) predicting travel mode choice found that habit was a significant predictor of car use, even when controlling for intention, and openly declared travel mode to be a habitual behaviour. The discrepancies between studies here may rely on the use of the RFM as a measure of habit: as previously seen the RFM has been challenged in its accuracy compared to other measures of habit (Møller & Thøgersen, 2008). However, the application of the RFM may be the issue: both studies mentioned applied the RFM through a paper survey, and because the method relies on fast responses in a time-pressure context (Verplanken, 2010), the studies may not have been able to capture the automatic nature essential to habit. Using SRHI or frequency/context measure methods to measure habit strength has consistently supported the



role of habitual behaviour in modal choice, and the described findings may not have captured the true automaticity of the behaviours.

So we may say that travel mode is habitual, but what are the implications? As this research has an interest in applying result to promote travel mode change, habitual behaviours present an increased challenge to changing behaviour. Using the TPB framework, changing travel behaviour is reliant on delivering information:

*“Complex human behavior is cognitively regulated and, even after numerous enactments, appears to be subject to at least some degree of monitoring. As a result, new information, if relevant and persuasive, can change behavioral, normative, and control beliefs; can affect intentions and perceptions of behavioral control; and can influence later behaviour” (Bamberg, Ajzen, et al., 2003, p.186)*

One of the most interesting effects of habit, however, is not only that automaticity can override intention, but also that habit influences how people seek, attend to, and retain information. A study by Aarts et al. (1997) investigated the information required by habitual or non-habitual bicyclists (using the RFM) to complete sixteen hypothetical trips with four variables available: weather, luggage weight, distance and departure time. Results indicated that habitual bicyclists required less information on these hypothetical trips to make their travel mode choice. This was supported by 3 studies using a similar methodology of possible information sources for travel mode choice (Verplanken et al., 1997) though replicated by using known trips, a novel (hypothetical) trip plan and a pure-information scenario where no trip-choice was required. All three studies indicated that stronger habits were linked to fewer requests for information, and sought information that confirmed their habitual mode. The idea of habits influencing information seeking to support one's own habit was supported by an experimental manipulation using a business decision-making scenario. Betsch, Haberstroh, Glöckner, Haar and Fiedler (2001) found increased routine use of a particular business choice led to participants continuing their routine choice in the face of logically superior options, even when presented with rational reasons for doing so. The studies above indicate how habit can influence information seeking preferences, but presenting information may also be counter-intuitive. A study (Tertoolen, van Kreveld, & Verstraten, 1998) presented tailored information on environmental damage and monetary costs of car use to regular car users. Instead of challenging expectations, Tertoolen et al. (1998) found no change in car use, and participants with pre-existing strong environmental beliefs actually reduced their concern for the environment, presumably to avoid the uncomfortable experience of cognitive dissonance (Festinger, 1962), where people's environmental beliefs conflicted with their car use behaviour, and changed their attitudes to continue the behaviour. There is also some evidence

to suggest that habit influences how information is remembered. A longitudinal study of experienced and remembered satisfaction with public transport (Pedersen, Friman, & Kristensson, 2011b) found that car users' remembered experiences of using public transport were significantly more negative than their recorded satisfaction when actually using public transport two years previously. Though no direct measure of habit was used, the study exemplifies how an assessment of an event is not purely rational, but can be biased by experience and expectations

The possibility of inaccurate information processing was regarded by Ajzen and Fishbein as fitting within the framework of the TPB;

*"...beliefs need not be veridical; they may be inaccurate, biased or even irrational. However, once a set of beliefs is formed, it provides the cognitive foundation from which attitudes, perceived social norms, and perceptions of control – and ultimately intentions – are assumed to follow in a reasonable and consistent fashion" (Ajzen & Fishbein, 2005, pg.193-194)*

Though recognising the potential for attitudes to be biased, the TPB would still maintain that information is processed in a logical order, and that information would still potentially change opinions (and thus behaviour). As seen above, the ability for new information to be sought, received and retained is challenged by the concept of habit. People have a bias to information that supports their own views (Hart et al., 2009), and interventions based on information provision produces some uncertain data. Meta-analyses of information campaigns for various health-related behaviours found only small effects ranging from  $r = .04$  to  $r = .15$  (Snyder et al., 2004), and even providing tailored health promotion information is only linked to an effect size of  $r = .07$  (Noar, Benac, & Harris, 2007). Discussing their meta-analysis, Snyder et al. (2004) also note that campaigns starting new behaviours were more effective than changing old behaviours – though it may be too much to apply habit theory to their analysis, other research has highlighted how considering habit can benefit information-based interventions.

An illustration of how habit and interventions influence behaviour is a study by Verplanken, Walker, Davis and Jurasek (2008) that measured car-use habit (using the SRHI), car use behaviour and environmental awareness, and compared those who had recently moved house to those who had lived in the same location for more than 12 months. Surprisingly, those who had recently moved home were more likely to act with their environmental beliefs and use the car less, compared to the people with similar environmental views that remained in a stable environment. This became known as the Habit Discontinuity Hypothesis: the weakening of habits through the removal, or changing of, contextual cues related to the habit.

The idea of breaking habit cues to facilitate information messages was originally proposed by Verplanken and Wood (2006) arguing that habitual behaviours (such as car use) may be open to context-change and individual-based approaches. Though Verplanken and Wood also argued that macro-level changes such as public policy, design of the local environment, social norms and technological advances may present opportunities for habitual behaviour intervention, this review will have to remain focused on individual, psychological interventions. Applications of the habit discontinuity theory however are few, and there is a definite need for more research in this area, with several researchers calling for greater application of the theory (van't Riet et al., 2011). One application of the theory includes the development of a healthy-eating guide that emphasises the need for positive behaviour in a consistent context, and achieved significantly positive effects (Lally, Chipperfield, & Wardle, 2008). However, there are two transport interventions that have actually capitalised on a context change for study, though without discussion or evaluation of the influence on habit. Survey work by Fujii, Gärling and Kitamura (2001) during an 8-day closure of a freeway found that car drivers who overestimated commute time by public transport were more likely to continue using public transport after trying it during the closure, with the authors concluding that the context change may influence the formation of new behaviours. Also, a study by Bamberg (2006) targeted residents moving home with a tailored travel information pack and free 1-day public transport ticket, and found a significant increase in public transport use. Though car habit significantly decreased after the move, Bamberg (2006) concluded that habit was not a factor as it was not linked to previous, or post intervention public transport use. However, even though the study used a flawed method of assessing habit (RFM with no real time constraints), the fact that all participants' car habits significantly decreased after the move, while the experimental group's public transport habit significantly increased, and that rational choice increased after the move, all lend support to the habit discontinuation hypothesis. By not comparing high/low habit participants on the level of change, Bamberg was not able to define habit as ineffectual in this study, and later research by Bamberg has capitalised on the use of context change to break habits (Schafer & Bamberg, 2008).

## **2.5 Affective influences on behaviour**

The previous two sections of this review both understand human behaviour as the result of mechanistic processes. The TPB (Ajzen, 1985, 1991) assumes that human behaviour is the product of attitude and belief calculations that progress through rational, linear steps. Habit theorists argue that behaviour may become an automatic response to stimuli outside of conscious thought: a learned response to contextual cues (Verplanken & Wood, 2006). Both approaches have their strengths, and have developed into predominant views in the field, but a recent trend within travel mode research has challenged these mechanistic views to introduce

a more human element – how people *feel* when they travel. This section of the review will discuss the experiential factors of behaviour, such as satisfaction, thrill, and prestige, and how these link to travel mode choice.

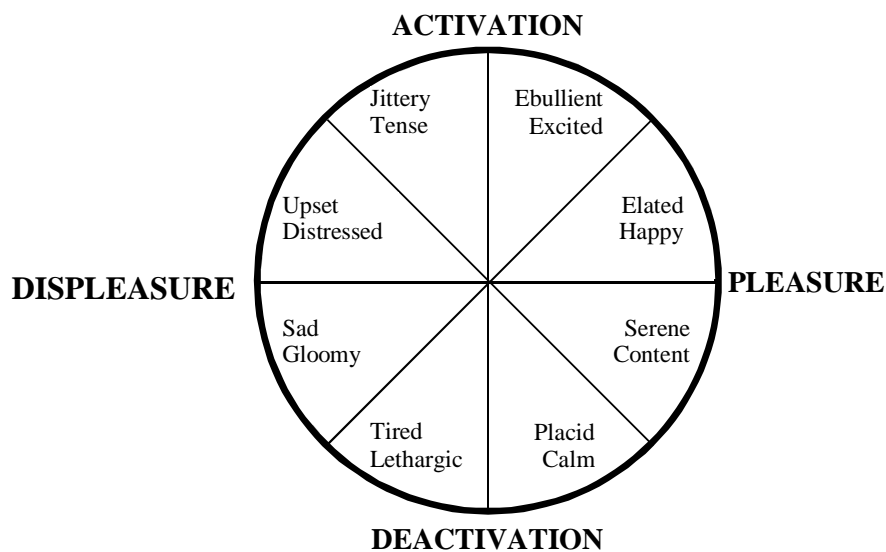
### 2.5.1 Defining the concept of ‘Affect’

Early social psychology theorists used the term ‘affect’ to refer a person’s attitudes towards an object: Ajzen (2001) highlights Thurstone’s (1931) classic discussion of measuring attitudes as an example. But since early work on attitudes, the term ‘affect’ has evolved into a complex and contentious topic in social psychology that is difficult to summarise, described by Ekkekakis as a “terminological Gordian knot” (2013, p. 33). The difficulty is compounded by the array of concepts that focus around three inter-related terms: Affect, Emotion, and Mood, which have often been used interchangeably (Batson, Shaw, & Oleson, 1992; Frijda & Scheerer, 2009). At the risk of oversimplification, Ekkekakis (2013) suggests the three concepts can be differentiated as follows.

A formal definition of affect is a "neurophysiological state consciously accessible as a simple primitive non-reflective feeling most evident in mood and emotion but always available to consciousness" (Russell & Feldman Barrett, 2009, p. 104). Examples offered by Russell (2003) include feeling tense, bored, calm, or elated. Notably, theorists use the term “Core Affect”, since the experience is a fundamental sensation that permeates through the concepts of emotion and mood, but also exists in isolation (Ekkekakis, 2013). An example given by Russell (2003) is feeling *pride* in oneself: a person can feel very positive (the core affect) when applied to their view of themselves (a cognitive aspect). Pride can be defined as an emotion, because of the complexity of states associated with the concept. Ekkekakis (2013) discusses the various mix of affective, cognitive, behavioural, attentive, experiential, neural and physiological changes that are consistent with the perceived emotion that occurs. Emotions are seen as deriving from a specific entity, be that a person or object or concept, but something that an individual perceives and reacts to. This facilitates the definition of mood, which requires no such catalyst, as Ekkekakis (2013) cites Frijda (2009): “the appropriate designation for affective states that are about nothing specific or about everything – about the world in general” (p. 258). For an individual, a mood is a global event that can lead to using any relevant object for emotive response (e.g., an angry mood may fix upon anything to feel emotions of anger), but the underlying cause of a mood might not be certain.

The three concepts of affect, emotion, and mood are interlinked, but the unique characteristic of core affect is its existence throughout each state. With the understanding that affect is “*any state that represents how an object or situation impacts a person*” (Duncan & Barrett, 2007, p. 1185), this opens a vast range of influences a person may experience. In response to the uncertainty within the field, Russell and Feldman Barrett (1999) published the

first use of the term ‘core affect’, and proposed the fundamental characteristics of affective responses. Using a two-dimensional grid, Russell and Feldman Barrett (1999) separate affect as a hedonistic pleasure-displeasure scale, and an excitation-based scale of activation-deactivation. The core affect grid states that a person’s affective experience can be a combination of the two axes at any given point: high pleasure and activation may be described as ‘exhilarating’ while high pleasure and low activation could be said to be ‘calm’ or ‘serene, and a negative but low activation sensation may be ‘dull’ or ‘dreary’. Russell (2003, p. 148) describes the use of the grid as an analogy of body temperature: we feel extremes, can note our current experience, but our experience of affect is ever present.



**Figure 5: The circular structure of Core Affect, contrasting the dimensions of pleasure/displeasure, and activation/deactivation. Adapted from “Core affect and the psychological construction of emotion” by Russell, J. A., 2003, *Psychological Review*, 110 (1), p. 140. Copyright 2003 by the American Psychological Association.**

Affect represents the “core” of emotions and moods (Duncan & Barrett, 2007, p. 1186), and as a response to external stimuli that involves positive or negative evaluations, affect is automatically created (Baumeister, Vohs, DeWall, & Zhang, 2007; Feldman Barrett & Tugade, 2004; Slovic, Finucane, Peters, & MacGregor, 2002). Defining affect as an automatic response is useful when differentiating between affect and emotions. One of the first to consider affect automaticity was Zajonc (1980), who proposed that affect may be an automatic process without requiring cognitive, rational consideration. It was previously believed that affect was a by-product of rational consideration of a behaviour or event’s emotion (Zajonc, 1980). Affective responses are more common and subtle than emotions, which are seen conscious states of feeling that are clearly distinguishable (e.g. happy, afraid, jealous) that tend to form gradually and change slowly over time (Baumeister, DeWall, Vohs, & Alquist, 2010). Despite popular belief that emotions are automatically generated, evidence for their automaticity is generally weak, while evidence for automaticity of affect can be

found in three areas (Feldman Barrett, Ochsner, & Gross, 2007): (1) subliminal presentation of positive or negative stimuli (e.g. emotive faces) can invoke responses in behaviour and facial expressions (Dimberg, Thunberg, & Elmejed, 2000); (2) briefly presented supraliminal and valenced stimuli facilitates responses to similarly valenced responses, such as implicit association measures (Greenwald, McGhee, & Schwartz, 1998; Nosek & Banaji, 2001); (3) measures of automatic affective responses (skin conductance responses) show changes when explicit and consciousness-reliant measures do not (Bechara, Damasio, Tranel, & Damasio, 1997).

Separating the constructs of affect and emotion is an important step in understanding how affective responses may influence cognition and behaviour. The idea that affect is separate from cognition has been suggested since the time of Aristotle and Plato (Duncan & Barrett, 2007), and can perhaps best be shown by the “Affect Heuristic” (Slovic et al., 2002). Developed in behavioural economics, the Affect Heuristic argues that affective judgments accommodate decision making by serving as fast and accessible indicators rather than employing the effort-intensive methods of cognitive deliberation (Finucane, Alhakami, Slovic, & Johnson, 2000). Kahneman (2011) offers a neat explanation by describing the affect heuristic as substituting a difficult question: “What do I *think* about this?” with an easier question: “How do I *feel* about this?” (p.139). Implications of the affect heuristic suggest that the affective interpretation of a stimulus may influence us towards non-rational choices. For example, Finucane et al. (2000) gave participants information on a power plant sources that highlighted one positive or negative aspect (e.g., risk) and assessed their views on an unrelated aspect (e.g., benefit). Finucane et al. (2000) found that positive information (e.g., low risk) led to greater support for other aspects (e.g., high benefit), and vice-versa across all variations; by inducing an affect-based response, they manipulated participant’s cognitive evaluations, despite the lack of a logical link.

The influence of core affect processes are vast, and vital for “all levels of cognitive processing, determining what people are conscious of, how they use and understand language, and what content is encoded and retrieved in memory” (Duncan & Barrett, 2007, p. 1186). Alongside cognition, affect is also increasingly viewed as having a “pivotal role in decision making and goal pursuit (Aarts, Custers, & Veltkamp, 2008, p. 557). Yet the role of affect in rational-choice models, such as the TPB, is a divisive topic. For Ajzen and Fishbein (2005), affect and anticipated affect are seen as behavioural beliefs, a subset of attitudes, and thus already factored into the TPB. However, Ajzen and Fishbein (2005) do recommend the measurement of both the experiential and instrumental aspects of attitudes toward an action. One meta-analysis explored how consistency between affect and cognition may influences TPB results: when affect and cognition was consistent, attitudes were significantly better

predictors of behaviour, but this link sharply decreased when affect and cognition were mismatched (Cooke & Sheeran, 2004). Investigations of the TPB's predictive ability have examined the role of affect in more detail. A meta-analysis of extended TPB studies measuring anticipated regret (Sandberg & Conner, 2008) identified the affective concept as an independent item, significantly improving intention variance by 7%, but explaining only an additional 1% of variance of behaviour (though core TPB constructs explained only 16% of behaviour variance). A more general meta-analysis (Rivis, Sheeran, & Armitage, 2009) using 32 tests of anticipated affect (both negative and positive) on TPB intention also indicated that affect was an independent factor that added an additional 5% variance explained, and also with a stronger link to intention than the core TPB concepts of Social Norms or PBC. Interestingly, anticipated negative affect was a stronger predictor than general anticipated affect, even when controlling for TPB variables, improving variance explained in intention to 7% (Rivis et al., 2009). Aarts, Custers, & Velkamp (2008) theorised that negative affect leads to reduced motivation to complete a goal, while positive affect enhances motivation, even when context of the affective response and the goal task have no similarities. While research continues on the influences of positive or negative feeling, the importance of affect; the automatic and 'core' response of positive/negative and activation/deactivation that underpins emotion and mood, is worth serious consideration in models of behaviour.

### **2.5.2 Affective evaluations of travel mode use**

Transport issues elicit a number of strong feelings in people: the term 'road rage' has become commonplace, and a seemingly mundane history of pedestrian road-crossing practices in the UK highlights public outrage and vilification of different road users (Moran, 2006). And yet travel can also produce great positive emotions, notably for car use, as Sheller (2004) remarked: "*Cars are above all machines that move people, but they do so in many senses of the word*" (p.221). Almost since their creation, the affection felt towards cars has been noted: Kenneth Grahame's classic book 'The Wind in the Willows' describes the car as "*poetry of motion*" (1908/2005, p. 21), and researchers since the 1970s have theorised that the car provides more than just a means of travel from place to place (Gatersleben, 2007). Investigation of affective responses to travel mode only arose in the late 1990s however; a report for the DETR<sup>6</sup> on attitudes to reducing car use (Stradling, Meadows, & Beatty, 1999, 2000) described how respondents with stronger affective links to car use were less likely to change, and 29% of respondents intending to drive more cited "enjoyment" as the key factor.

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<sup>6</sup>'Department of the Environment, Transport and the Regions' replaced by the Department for Transport, Local Government and the Regions (DLTR) in 2002.

Perhaps the first true study of affective aspects of car use was a study by Steg, Vlek and Slotegraaf (2001) who separated the role of car use into three constructs: instrumental (actual function of the car), affective (emotional value of using/owning a car) and symbolic (identity and social value of the car). Steg et al. (2001) used three methods to determine how people viewed car use, each method varying in the expected intention of the task. Participants (in groups) first sorted 32 scenarios of car use into different piles, each pile reflecting a similar theme among the scenarios. Secondly, participants then ranked the 32 scenarios according to their attractiveness, and thirdly the participants rated 60 car use aspects for attractiveness using a 5-point Likert scale. The 60 items were prepared through a literature review of car-use motivations, and the 32 scenarios reflected concepts highlighted in the list of 60 items. Analysis of all three methods indicated a gap between the explicit attractiveness ratings (as with rating the 60 items) and the more implicit attractiveness ratings (with the 32 scenario sorting tasks). The authors felt that when giving people an explicit test (ranking 60 items) it allowed people to rationalise their views to more socially-acceptable values, and rated instrumental items as the most important. For the more subtle methods (scenario-sorting), symbolic and affective values of experiences were stronger than instrumental reasons – the highest rated scenario read:

*“Finally, you bought your dream car. Your neighbour watches in admiration when you are testing your new car. The car holds the road well.” (Steg et al., 2001, p.167)*

A number of other studies have highlighted the importance of symbolic and affective values of car use using various methods. The value of qualitative studies in this area is described as overcoming the potential for rationalisation of affective or symbolic motives to instrumental reasons; interviews may allow participants to “overcome self-presentation biases and reveal the complexity of motivational structures” (Gardner & Abraham, 2007, p.188) and “reflect on their own interpretations over time” (Mann & Abraham, 2006, p.158). Qualitative studies using interviews and focus groups for car use motives often highlight the affective values of freedom or autonomy (Gardner & Abraham, 2007; Hagman, 2003; Hiscock, Macintyre, Kearns, & Ellaway, 2002; Mann & Abraham, 2006), as well as personal space (Gardner, 2009; Mann & Abraham, 2006), ‘ontological security’<sup>7</sup> (Hiscock et al., 2002), and also symbolic values of maturity and social status (Hiscock et al., 2002; Mann & Abraham, 2006).

Qualitative research on other travel modes is, however, limited. Some of the work mentioned above discussed general public transport (i.e. trains and buses) either dismissing the modes for lacking ontological security (Hiscock et al., 2002), loss of personal space

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<sup>7</sup> Defined as a combination of “protection, autonomy and prestige” (Hiscock et al., 2002, p.120)



(Mann & Abraham, 2006), and the lack of autonomy (Gardner & Abraham, 2007). Studies that directly explored bus use highlight the positives of relaxation time (Beirao & Cabral, 2007), the chance to ‘people watch’ (Stradling, Carreno, Rye, & Noble, 2007) and a space for social interaction (Guiver, 2007). These studies also reflected the negative affect of bus use: perceived low social status (Guiver, 2007), the discomfort of other's people's noise/smell/space invasion (Stradling et al., 2007), and again a lack of autonomy (Beirao & Cabral, 2007). However, one paper, exploring walking (Darker, Larkin, & French, 2007), highlighted the relaxing and potentially social aspects as positive. For bicyclists, positive affective experiences related to the fun and excitement (Bonham & Koth, 2010; Daley & Rissel, 2011), a sense of freedom (Daley & Rissel, 2011); though negative responses saw bicycling as a lower status travel mode (Daley & Rissel, 2011), or as an ‘outsider’ group (O’Connor & Brown, 2010) challenging the symbolic value of bicyclists.

This is not to say that quantitative studies have been unable to find affective or symbolic reasons for travel mode choice; survey methods also highlight affective motives of travel. Survey analysis of commuting or leisure travel found that affective factors (e.g., relaxation, control) were reported as more important than instrumental factors (e.g., convenience, cost) for leisure travel, but not for commute travel (Anable & Gatersleben, 2005). In contrast, Steg (2005) found that the reported satisfaction from symbolic and affective factors of car use (e.g., “express myself through my car”, “I get a kick of driving”) was significantly higher for regular drivers, while attractiveness of instrumental factors did not vary by level of driving. The contrast may be due to the focus of the question (trip mode vs. car use frequency), or perhaps the short scenarios used by Steg (2005) allowed more context in responses that facilitated a desire for affective experiences; less-explicit questions have encouraged affective motives to emerge in previous work (Steg et al., 2001).

More theory-based survey approaches have been applied to affective appraisals of the commute, notably the work by Gatersleben and Uzzell (2007). Applying principles of Core Affect (Russell, 2003; Russell & Barrett, 1999) indicated by users of different travel modes, Gatersleben and Uzzell (2007) demonstrated the multi-faceted affective appraisals of modal choice, such as the positive and relaxing aspect of walking, contrasting the depressing and boring experience of bus use. Later work expanded the application of Core Affect, and alongside cognitive evaluations of mode use (e.g., “travel worked well/worked poorly”), were combined into a single measure of travel experience called the Satisfaction with Travel Scale (STS; Ettema et al., 2011). Applications of the STS indicate that between travel mode choices, satisfaction increases from low public transport satisfaction, then to car use, with highest satisfaction found by active modes of walking or bicycling (Friman, Fujii, Ettema, Gärling, & Olsson, 2013; Olsson, Gärling, Ettema, Friman, & Fujii, 2012).

A difficulty found by several researchers (Gardner & Abraham, 2007; Gatersleben, 2007; Mann & Abraham, 2006) is the apparent ‘blurring’ between concepts of affect and utility. That is, the utility of a travel mode has implications towards the affective response towards the travel mode, and the two concepts are often linked. An example given by Mann and Abraham (2006) is the time using a travel mode and the affective implications: public transport was seen by some participants as slow, which induced negative affect. Another example is that the cost of public transport elicited strong negative emotions, but the cost of car use and parking was acceptable when linked to affective concepts of freedom and control. It has been suggested that the successful travel trips may even improve a person’s subjective well-being (Ettema et al., 2011; Jakobsson Bergstad et al., 2011), further highlighting the blending of affective experiences, and also the importance of affect.

### **2.5.3 Influences of Affect on Travel Behaviour**

Transport creates a number of positive and negative affective responses, which raises the question of whether affect has a direct influence upon travel mode choice. Describing a causal link between travel-related affect and behaviour is difficult however, since the majority of research is exploratory, and with a limited amount of research (Gatersleben, 2007). The clearest investigation of affect and travel mode choice was reported by Steg (2005) across two studies. The first study by Steg (2005), as mentioned earlier, highlighted the various affective instrumental motives with car use, while the second study applied these concepts to predicting car use. Using a sample of regular rush-hour commuters, a survey recorded car use motives for instrumental reasons (based on the Theory of Planned Behaviour), symbolic reasons, and core affect experienced when using the car. Even when exploring car use in a journey assumed to be more instrumentally-reasoned, instrumental factors were not a significant predictor, while core affect was a significant and independent predictor of car use. In total, 28% of rush-hour car use could be explained by descriptive norms (how others behaved), social norms, core affect, and social comparison (Steg, 2005).

Alternatively, the automatic nature of affect may influence cognition and behaviour in more subtle ways. An economic simulation of modal choice, with the goal of minimising the objective travel time found a strong preference for car use in “refutation of the rational model” (p. 166), which the authors suggest is due to the affect-based motives of car use (Innocenti, Lattarulo, & Pazienza, 2013). In their qualitative discussion, Mann and Abraham (2006) discuss a participant’s hostility to the costs of public transport, but accepted the costs of car use, arguing that his choice was not based on cost/benefit analyses, but “his different affective reactions to the costs of using a train and driving” (p. 161). The affect-based preference for car use over alternatives, especially public transport, can even influence the perception of satisfaction; work by Tore Pedersen and colleagues highlights how car use habit

causes bias against alternative modes. People with stronger car habits had significantly higher expected dissatisfaction with public transport (Pedersen, Kristensson, & Friman, 2012), and using public transport actually led to significantly higher evaluations of public transport than first predicted (Pedersen, Friman, & Kristensson, 2011a). But even after using public transport, participant's remembered satisfaction of bus or train use was significantly lower than their recorded satisfaction at the time of use (Pedersen et al., 2011b). Ultimately, people have biased expectations, which are likely inaccurate, but even after experience the remembered satisfaction may be negatively biased. Anticipated regret is a powerful influence on behaviour (Rivis et al., 2009), which can restrict people from exploring alternative options (Mellers & McGraw, 2001).

Research on affect and travel mode is still relatively young, and reviewing the research often leads to more questions than answers (Gatersleben, 2007). But even with our developing understanding of affect and behaviour, researchers have also raised concerns about the affective implications of changing behaviour when considering the psychological benefits of car use (Hiscock et al., 2002). In a review of travel behaviour change, possible long term implications of car use reduction are gravely listed as "reduced subjective and objective well-being, worse family functioning, psychological and physiological stress" (Gärling, Gärling, & Loukopoulos, 2002, p.99). Though the affective value of car-use is often documented, the belief that car use reduction may lead to negative consequences seems to ignore the positive attributes and psychosocial benefits of alternative modes; such as relaxation in walking (Darker et al., 2007), freedom when bicycling (Daley & Rissel, 2011), or the sociability of public transport (Guiver, 2007). Nonetheless, this area of research requires more input in exploring what affective implications are found within travel modes, and whether addressing these can encourage behaviour change in a way that avoids creating negative affect.

## **2.6 Combining Habit and Affect as research topics**

Habit and Affect have been discussed as alternative sources of influence for travel mode choice in relation to the TPB (Ajzen, 1985, 1991); the predominant model of reasoned behaviour. These alternative concepts can be defined by their automaticity: Habits are automatic in their application and triggering by context (Verplanken & Wood, 2006; Wood & Neal, 2007), and Affect is an automatic experience of valence (Feldman Barrett & Tugade, 2004; Slovic et al., 2002). Additionally, both habitual (Gardner, 2009; Gardner & Abraham, 2008) and affective (Rivis et al., 2009; Steg, 2005) influences have been demonstrated as independent of the reasoned variables within the TPB. The shared characteristic of automaticity of habit and affect, contrasting with the reasoned principles of the TPB, is worth a brief discussion, and may be understood from the perspective of Dual Process models.

### 2.6.1 Dual Process Models

Separating fast and slow cognitive processes is not new: the writings of Plato, René Descartes, John Locke, William James, and Sigmund Freud all show some consideration of the division between considered and automatic thought (Frankish & Evans, 2009). But the modern separation of mental processes wasn't clearly defined until the cognitive revolution of psychology in the 1960s (Frankish & Evans, 2009), when the idea of distinct cognitive processes became accepted in lieu of the behaviourist doctrine of pure observation (Schultz & Schultz, 2008). As research uncovered decision heuristics and rational/biased conflicts (Kahneman & Tversky, 1979), a theoretical separation of processes developed to explain such conflicting results (Evans & Stanovich, 2013), which developed over time to what are now often described as Dual Process models (Evans, 2008; Stanovich, 2011; Strack & Deutsch, 2004).

A formal definition of dual process models is difficult, and with little agreement on basic structure of dual processes: the cause of much controversy (Stanovich & Toplak, 2012). The complication arises from the fact that there are many individual dual process theories (Evans & Stanovich, 2013). With many variants of theories, descriptions of dual process concepts also vary: Evans (2008, p. 268) describes the “epidemic” of terminology when listing 23 different definitions. With several terms used, such as implicit/explicit, non-conscious/conscious, or experiential/rational, Evans (2008) instead offers the use of the general concepts of ‘Type 1’ and ‘Type 2’ processing. For a consolidated view of Types 1 and 2 processing, two of the most influential dual process theorists offer a combined discussion to clarify the concepts. Evans and Stanovich (2013) state that “the defining characteristic” for Type 1 processes is automaticity (p. 236). Highlighting the fast nature of Type 1 processes, the limited amount of cognitive processing required, and the lack of conscious activation required, Type 1 processing includes many elements that are related by autonomy. On the other hand, Type 2 processing is closely linked with a person's intelligence (Evans & Stanovich, 2013). With complimentary views, Evans (2008) views Type 2 processes as dependent on working memory and involving higher-order cognition and rule-based reasoning, while Stanovich (2011) defines Type 2 by the ability to create hypothetical thought and disengagement from Type 1 processes for reflection on strategy and decision.

Evidence for Dual Process theories generally come from three areas (Evans & Stanovich, 2013): experimental tasks, neuroimaging studies, and individual differences. Experimental tasks have highlighted discrepancies between types of processing used: people under time-pressure constraints often show reduced logical reasoning (Evans & Curtis-Holmes, 2005) and increased use of inefficient routines (Betsch, Haberstroh, Molter, & Glöckner, 2004). Even without time limits, people demonstrate a reliance on automatic

stereotypes for logically-invalid decisions (Tversky & Kahneman, 1983), or use intuitive biases based upon context rather than logic (Evans, 1998). The distinction between responses from reasoned or automatic processes is supported by neural imaging tasks, which highlight how different brain areas are activated. When evaluating performance on a belief-bias task<sup>8</sup>, increased bias (logically invalid assessments) was linked to reduced activation of the inferior frontal cortex; an area believed to have inhibitory control of Type 1 processing (Tsujii & Watanabe, 2010). A similar context-influence task showed activation of the prefrontal cortex when reasoned responses were shown instead of using automatic stereotypes, and also report activation of the anterior cingulate; thought to be involved with conflict detection (Neys, Vartanian, & Goel, 2008). With conflict between logically correct and intuitive responses, further evidence for dual process accounts are found in differences of intelligence. With the theorised link between Type 2 processing and intelligence, several studies have found that intelligence is positively linked with more reasoned and logical responses in experimental tasks (Evans & Stanovich, 2013). This is not always the case however: a number of heuristic and judgment tasks show limited correlation with intelligence (Stanovich & West, 2008). Alongside individual differences in intelligence, personal motivation to identify the necessity of, and then to actively engage Type 2 processing, is additionally required (Stanovich, 2011). With results from experimental tasks that suggest two types of reasoning, neurological differences linked to these reasoning types, and recognisable characteristic differences between individuals for performing types of reasoning, Dual Process approaches offers a concise framework that explains a range of reasoning and decision making tasks (Evans & Stanovich, 2013).

But there is still considerable debate surrounding dual process theory. Several authors have challenged dual process accounts, noting inconsistencies and widely varied terminology (Keren & Schul, 2009; Kruglanski & Gigerenzer, 2011), while suggesting that mental processes may not so easily be claimed as independent (Keren & Schul, 2009), and that evidence can more easily be explained by a single, rule-based, approach (Kruglanski & Gigerenzer, 2011). Proponents of the dual processes framework have fiercely defended the conceptual model, but do make allowances for the confusion of terms and sometimes limited amount of research (Evans & Stanovich, 2013). But even with debate on the identification of dual process *types*, theoretical work is now expanding to explore dual process *modes* that seek to understand how the cognitive processes interact (Evans, 2010). This debate has led to the formation of new interlinking theories that have expanded the number of processes: both Evans (2009) and Stanovich (2011) have proposed models that now include three distinct

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<sup>8</sup> Syllogisms that intuitively appear correct, but are logically invalid. An example by Stanovich (2011) is: 1) All living things need water; 2) Roses need water; 3) Roses are living things.

processing types. Although dual process accounts have risen in popularity, there is still a large amount of uncertainty and investigation required to define what processes exist, and how they interact. But even as a developing concept, dual process accounts offer a broad and useful theoretical framework to consider habitual and affect-based influences on behaviour.

### **2.6.2 The need for Habit and Affect research in travel mode choice**

Since habitual processes and affect-based responses are automatic, fast, and require limited cognition, both concepts fall under the definition of Type 1 processes proposed by Evans and Stanovich (2013). Accordingly, rational-choice models that consider reasoned decision making based upon consciously-accessed attitudes and beliefs, such as the Theory of Planned Behaviour (Ajzen, 1985, 1991), comply with Type 2 processes. Despite the modern framework of dual-process models, there have been suggestions to combine automatic concepts within the TPB for some time. In their review of the TPB, Conner and Armitage (1998) highlight several potential additions, including the roles of habit and affect, that could be combined within a dual-process approach. Since their review, the potential for automatic-concepts continues to be promoted as potentials for improving conceptual models of behaviour change. Discussing health promotion techniques, Sheeran, Gollwitzer & Bargh (2013) highlight the apparent weakness in interventions that only target conscious attitudes to change behaviour. Reiterating the potential for dual process models, and specifically highlighting habit and affect, the authors encourage the exploration of automatic cognition for behaviour change approaches (Sheeran et al., 2013).

Transport research has not failed to recognise the development of automatic concepts, and has begun to revise the previously held “utopian view” of purely reasoned behaviour (Lyons, Avineri, Farag, & Harman, 2007, p. 2). Noting the complexity of factors involved with planning a trip, and the varied levels of information that need to be sought and processed, a recent movement has begun to explore alternative factors on behaviour; including habit, heuristics, and affect (Nyblom, 2014). In particular the concepts of habit and affect are frequently discussed as avenues for better understanding travel mode choice. In a series of focus group discussions on how information is used for modal choice, Kenyon and Lyons (2003) concluded that while information is useful for planning trips, modal choice is more influenced by peoples’ habitual and affective responses. Analysing interviews for people’s views on travel and environmental issues, Chatterton et al. (2009) conclude that affective responses to car use were so dominant that car use was seen as “a basic human right” (p. e47), and that habit also needs to be considered before supplying information that may be ineffective. Even within an economic simulation that required participants to only consider financial costs of modal choice, Innocenti et al. (2013) report the “affective

dominance of cars” (p. 165), and the role of habitual choices that defied their reasoned models of choice.

Habit and affect are developing ideas within travel mode choice, and are becoming increasingly recognised as important characteristics to consider. In order to fully understand these factors, and thus to apply knowledge to encourage sustainable travel mode choice, more research is needed. In a review of research on the determinants of modal choice, habit strength was found to be a significant predictor in 75% of studies: one of the most reliable predictors of mode choice, but only rarely studied in the literature (De Witte, Hollevoet, Dobruszkes, Hubert, & Macharis, 2013). The importance of affect has also been emphasised within this chapter, but with only a limited amount of investigation, there is a recognised need for further exploration of affective motives for pro-environmental behaviour (Gatersleben & Steg, 2012).

## **2.7 Conclusion**

The goal of this review is to encapsulate the background surrounding a conflict between reasoned and automatic influences upon travel mode choice. Charting the initial success of the Theory of Planned Behaviour to predict travel mode choice, the emergence of habitual and affect-based influences are reviewed as powerful and independent factors upon behaviour. Using dual-process models as a theoretical framework, this review considers how automatic concepts require further investigation in travel mode choice. With growing support for habitual and affect-based influences on behaviour, this review proposes the purpose behind this thesis: to explore habitual and affective components of travel mode choice. The goal is to investigate and clarify how these concepts may influence our behaviour, and pivotally, how these factors may be used in the promotion of sustainable travel mode choice.

## **Chapter 3: Qualitative exploration of travel mode choice within the context of a CO<sub>2</sub> reduction target**

*“You need to know how, what they do at the moment, and . . . what ways they’re susceptible to having their behaviour changed”*

- **Alex, Motorcyclist (682:684)**

### **3.1 Abstract**

*In a UK university, focus groups were held with users of different travel modes to discuss carbon targets, behaviour change and views on commuting options. Six focus groups were held with 27 participants who self-identified as regularly commuting by car, motorcycle, bicycle, bus, or by walking. Using a Grounded Theory approach, an emergent theory with four core-categories was developed. This chapter outlines the explanatory theory, conflict, and agreements between groups on various transport-related issues in the face of a CO<sub>2</sub> reduction target. The main value that emerged as important within a travel mode was the personal freedom that it delivered. Though environmental support differed between travel modes, the desire for freedom and autonomy in a journey were the strongest reasons for maintaining a travel mode, and also guided views on CO<sub>2</sub> emission targets. Bus users were unique, however, with little control and low satisfaction, desiring more control in their journey but having limited interest in changing mode. The implications of the findings are discussed within a framework highlighting the importance of autonomy and affect in travel mode choice, leading to a model exploring the role of control and reflections of environmental issues related to travel.*

### **3.2 Introduction**

As mentioned in the Chapter 2 literature review, efforts to reduce car use often employ rational choice models such as the Theory of Planned Behaviour (TPB; Ajzen, 1985) as a basis of explaining mode choice. Rational choice models view behaviour as the formation of consciously-formed intentions, created by weighing various options toward the behaviour. For example, the TPB considers intentions to be formed by a person’s Attitudes, their Social Norms, and Perceived Behavioural Control. The effectiveness of interventions to reduce car use, often using information or incentive campaigns to improve attitudes, is still an uncertain picture however. Large scale meta-analyses show a slight to moderate reduction in driving following interventions, but note the possibility of heavily biased evidence bases that overestimate intervention effectiveness (Möser & Bamberg, 2008). A narrative review of the field suggests a similarly pessimistic view of intervention effectiveness, and notes the limited



quality of research reports (Graham-Rowe, Skippon, Gardner, & Abraham, 2011). Seeking more reliable results, a recent meta-analysis of a select, but rigorous, sample of best-practice research indicates no effect of interventions on car use (Walker & Thomas, *in preparation*). With unclear to ineffective conclusions of behaviour change interventions, it may be of interest to return to examinations of personal motivations towards car use, in order to fully understand the behaviour, in order to effectively promote sustainable alternatives.

A meta-analysis of car use motivations, using studies from a range of theoretical backgrounds (Gardner & Abraham, 2008), highlights the wide variability of influences for either using, or for not using, the car. Their meta-analysis of 23 published datasets suggested that the TPB was a significant predictor of car use, explaining 23% of variance in behaviour (Gardner & Abraham, 2008). In addition to traditional rational-type constructs, Gardner and Abraham also found that the automaticity of habitual influences were strongly linked to car use, and the authors conclude that both the TPB and habits capture a separate entity of travel mode motivation highlighted, also supported by other authors (Verplanken, 2006; Verplanken, Aarts, Van Knippenberg, & Moonen, 1998; Wood & Neal, 2007). An alternative set of automatic influences upon modal choice (alongside habitual processes) have also developed in recent years: affect-based satisfaction. Affect is an aspect of car use that relates to the symbolic and experiential uses of the car (Steg, Vlek, & Slotegraaf, 2001), which may be a successful predictor of car use (Steg, 2005), but is also a complex mix of various affective evaluations (Gatersleben & Uzzell, 2007), psychosocial benefits (Ellaway, Macintyre, Hiscock, & Kearns, 2003), and simply driving for fun (Handy, Weston, & Mokhtarian, 2005; Musselwhite & Haddad, 2010).

Given the possibility that there is a mix of reasoned, habitual, and affective influences on modal choice, taking an exploratory qualitative approach would be a useful means of investigating mode choice motivations. Taking a more open-ended approach to begin investigation in this thesis may provide new insights into how the concepts interplay, and guide later research as discussed later in this thesis. The value of qualitative methods to uncover new research enquiries is well documented (Murphy, Dingwall, Greatbatch, Parker, & Watson, 1998; Tashakkori & Teddlie, 2010), and understanding motivations for travel mode choice through qualitative research can provide additional insights when forming a later quantitative approach (Tashakkori & Teddlie, 2009). Establishing research ideas for future quantitative work to complement reiterates the opportunity for Triangulation (Lieber & Weisner, 2010) with mutual corroboration between qualitative and quantitative results (Bryman, 2008). Applying qualitative approaches to define future quantitative work in transport research has also been encouraged to identify appropriate research topics (Schwanen, Banister, & Anable, 2011).

A second motive for exploratory research is to address identified gaps in the Chapter 2 literature review. With a limited amount of qualitative work, the majority of qualitative research focuses only on car users' motivations and experiences. Investigating affective motives for car use using Interpretive Phenomenological Analysis, Mann and Abraham (2006) highlighted four themes of affect-based satisfaction: providing personal space, car use identity, autonomy, and the positive affect from travel (e.g., comfort or thrills). Using Grounded Theory, Gardner and Abraham (2007) considered car use motivations among regular drivers, and described similar themes of personal space and autonomy, as well as a blurring between affect and utility so that instrumental benefits (such as speed) provided positive affect. Within a context of carbon emissions reduction, Chatterton et al. (2009) used a variant of Matrix Mapping to analyse interviews, and found strong ties to concepts of freedom, status, and affective experiences that helped maintain car use. We can see, then, that car use and autonomy is a common theme expressed through other qualitative reports (Ellaway et al., 2003; Hiscock, Macintyre, Kearns, & Ellaway, 2002), but studying alternatives to car-use remains largely unaccounted for, and we don't know if similar motives would arise for other modes. An investigation of Portuguese bus users found that while some enjoyed the social interactions, others felt that waiting, high costs, and a lack of information were negatives of public transport (Beirao & Cabral, 2007). Walking for commuting was briefly explored in a discussion of exercise: reported satisfaction was high, but walking for transport was limited by negative perceptions of distance and time (Darker, Larkin, & French, 2007). For bicyclists, Daley & Rissel (2011) reported discussions with an Australian sample about the fun and healthy side of cycling, while participants also highlighted fears of danger, and the overly 'serious' side of bicycling that dissuaded bicycling as a transport choice.

It is also surprising how only a few direct comparisons of mode choice exist. Reports often focus on motivations of one travel mode user (Gardner & Abraham, 2007), or compare users and non-users of one mode (Daley & Rissel, 2011), or pair two modes against each other (Beirao & Cabral, 2007), or include an unspecified mix of modes (Buys & Miller, 2011). What is required is a direct comparison of people who use a range of different travel modes, to the same location, in order to understand similarities and differences between mode groups. Using a fixed destination removes some of the variability that location and geography may account for, and gives greater emphasis to the motives underlying the choice of travel mode. With the novelty of comparing a range of behaviours in one analysis, an exploratory qualitative technique is appropriate for "venturing into new territory" (Willig, 2008b, p. 1). Coupled with the range of affective experiences that may be found when comparing various modes, an exploratory approach across a range of choices may uncover a common theme not previously found.

A qualitative approach also offers participants the opportunity to give more detailed responses, and possibly to discuss topics they may not indicate within conventional measures. Affective links to car use are more clearly indicated when measures are more indirect (Steg et al., 2001), and the same may be found for other mode users. Qualitative approaches can “overcome self-presentation biases and reveal the complexity of motivational structures” (Gardner & Abraham, 2007), and also allows participants to “reflect on their own interpretations over time” (Mann & Abraham, 2006, p. 158). Encouraging flexibility in participant’s responses, and mitigation of presentation bias, could allow more automatic and affect-based responses to be introduced, which may facilitate the current research goal for alternatives to rational-choice and instrumental concepts.

To compare users of different modes within a qualitative framework, a point of reference was required to generate discussions. Extensive private car use has severe repercussions of impact upon the environment through carbon emissions (Berntsen & Fuglestad, 2008; DECC, 2014). Yet public concern for climate change in the UK has fallen in recent years: a 13% drop in belief in climate change since 2005, with an 11% fall in those concerned about the impact of climate change (Spence, Venables, Pidgeon, Poortinga, & Demski, 2010). Falling climate change concern in the UK is further compounded by rising scepticism that the problem actually exists (Whitmarsh, 2011), and perceptions that the impact of climate change is exaggerated (Shuckburgh, Robinson, & Pidgeon, 2012). Discussions of carbon emissions, climate change, and environmental actions often reveal a large amount of confusion and misunderstanding of the topics (Chatterton et al., 2009; Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; Whitmarsh, 2009; Whitmarsh, Seyfang, & O’Neill, 2011). With falling support, rising scepticism, and confusion over the topics involved, research needs to understand the complexity of personal knowledge toward reducing transport emissions (Anable, Lane, & Kelay, 2006)

Qualitative approaches to transport have only touched upon environmental concerns, however, and instead often focus on the affective experience of modal choice. For car users, Mann and Abraham (2006) suggested that some participants expressed guilt over car use, while Gardner and Abraham (2007) reported no mention of environmental issues from car users, which they suggest indicates a lack of concern when considering modal choice. In the broader context of climate change, Chatterton et al. (2009) found that while car users felt guilt over emissions, a perceived lack of practical alternatives restricted any behaviour change, with the authors suggesting that this guilt may develop into increased resistance to change, presumably through cognitive dissonance between attitudes and behaviour (Festinger, 1962). Alternatives to car use also report minimal discussions of the environment. The environment was not discussed when evaluating walkers (Darker et al., 2007), and one participant in

Beirao & Cabral's (2007) study briefly mentions emissions as a possible reason for bus use, while another dismisses changing behaviour since bus and cars both produce emissions. For cyclists, the stereotype of 'green' cyclists was observed (see also Gatersleben & Haddad, 2010), and while some cyclists enjoyed the sustainability benefits, it was often not a prime motive for bicycling (Darker et al., 2007).

In summary, given the lack of work that directly compares users of several different travel modes, this chapter will use a qualitative approach to investigate motivations and experiences of modal choice. In addition, with a limited understanding of how modal choice relates to environmental views, the context of the discussions will invoke considerations of CO<sub>2</sub> and carbon emissions, and how behaviour change in light of carbon reduction is viewed. The use of qualitative work is to facilitate an exploratory approach, and the intention is to highlight comparisons between travel modes that may facilitate new research topics for future investigation.

### **3.3 Study 1**

#### **3.3.1 Ethical Approval**

Approval was granted by the University of Bath Department of Psychology ethics committee, Ref: 11-872.

#### **3.3.2 Focus Group Method**

With a vast range of qualitative approaches to data collection (Willig, 2008b), a focus group design was chosen for three main reasons. First, focus groups are one of the most popular methods to use in the exploratory stage of a mixed methods investigation, especially for designing later quantitative measures (Barbour, 2007; Bloor, Frankland, Thomas, & Robson, 2001; Stewart, Shamdasani, & Rook, 2007). Given my requirement to develop concepts for an upcoming survey, as part of the initial exploratory work, focus groups were an ideal method to begin this thesis. Second, focus groups encourage social interaction between participants, allowing participants to make sense of a topic in a naturalistic way, which can encourage genuine expressions and views to be expressed (Farquhar & Das, 1999; Smithson, 2008; Stewart et al., 2007). In addition, the focus groups were designed to have users of only one mode present, so that views could be expressed without challenge from other mode users, to encourage participation and develop group dynamics (Stewart et al., 2007), and to cover topics in more depth (Bloor et al., 2001). Lastly, focus groups can be a more accessible approach for views on why people *don't* perform certain behaviours (Barbour, 2007), e.g., why people don't use sustainable travel modes. One-to-one interviews may force people into a defensive position and seem accusatory, while a focus group allows a group to generate a response and place actions in a broader context, and has proved a useful approach for

understanding behaviours that may be negatively viewed (Barbour, 2007). Resistance to car use reduction can develop by challenging environmental views (Tertoolen, van Kreveld, & Verstraten, 1998), and discussing car use emissions can lead to feelings of guilt and resistance (Chatterton et al., 2009). With an aim to discuss transport and CO<sub>2</sub> emissions, focus groups may alleviate persecutory concerns to encourage participation and reduce resistance within the sessions.

In a semi-structured method, six statements were designed to cover a range of topics on transport, carbon emissions, and behaviour change. At the beginning of each group, I discussed the statements as ways of starting conversation; it was made clear that these did not reflect actual policy but were possible views. Throughout each session, statements were introduced after around 10 minutes of discussions, or once the previous topic had drawn to a close. The statements were discussed in the order shown below:

1. *The University of Bath has recently committed to reducing its Carbon Footprint by 40% by 2020. Do you think that transport, and the way people travel, can play a part in achieving this target?*
2. *If the University made a publicised announcement that senior department heads and the vice-chancellor were to start using 'greener' transport modes, what would your reaction be?*
3. *With the upcoming travel survey for the University, there may be discussion people should walk more because it's the most environmentally friendly way and has zero-to-no accidents. Do you think that this is a legitimate view?*
4. *If the University only had a limited budget for a new Travel Plan, which of the four modes of transport (car users, motorcyclists, public transport users and bicyclists) do you think should receive the most funding?*
5. *Thinking about your normal commute to the University, how would you describe it in terms of satisfaction?*
6. *If you had a new member of staff join your department, or a new student joins the class, how would you recommend they travel to the University campus?*

Where time became limited, question six was not asked or given a short space of time. Participants were asked for their views on the topics introduced, and informed that all responses were valid and would be recognised. Follow-up questions were asked when certain points were raised, though the main policy was to encourage conversation by letting participants discuss topics as a group.

Consent forms describing the nature of the research and how the data were to be used were distributed and signed by participants and the researcher. Groups were held in teaching

rooms across campus, each lasting approximately one hour, and recorded using a 'Zoom H1 Handy Recorder' (Stereo). Discussions were transcribed verbatim, using audio recordings and handwritten notes.

### 3.3.3 Participants

Participants were staff and students from the University of Bath, a campus-based university on the outskirts of the city of Bath, UK. Participants were recruited by various means - emails were sent to a bicyclists' user group and a motorcycle/scooter users' group, posters displayed near campus bus stops, and an article published on the internal University webpage. Advertisements requested people who self-identified as travelling to campus by one of four methods – bicycling, bus, motorcycle/scooter or driving a car. In addition to the four primary groups, one staff member who regularly walked to campus expressed an interest in taking part and suggested two colleagues who similarly walked and would also be interested. Though not initially considered, a focus group was held with the walkers to increase variation in the sample and strengthen the validity of the research.

In total, six focus groups were held with 27 participants: two groups with bicyclists (because of high demand) and one group for car users, for bus users, for motorcyclists and for walkers. The two cycling groups held 3 and 6 participants respectively, motorcyclists held 5, car users held 6, bus users comprised 4 participants and 3 walkers attended the last group. Groups only contained people using the same mode to encourage collaborative and cohesive group discussions on their mode choice: facilitating understanding of users of a particular mode. The majority identified themselves as 'White British', with exception of one 'Irish', one 'British/Scandinavian', and two refusals to specify. Group demographics are outlined in Table 1 below.

**Table 1: Demographics of focus group participants**

Group	N	Age Range	Gender
Bicyclists (1)	3	22 - 38	3 Male
Bicyclists (2)	6	38 - 65	4 Male, 2 Female
Motorcyclists	5	23 - 60	5 Male
Car Users	6	25 - 53	4 Male, 2 Female
Bus Users	4	20 - 62	1 Male, 3 Female
Walkers	3	41 - 52	3 Female

Participants for car and for bus user groups proved more difficult to recruit. Advertisements published on the University's internal newsfeed for car or bus users included an incentive of £5 for students or a £5-valued voucher for staff. Participants for the bicyclist, walking and motorcycle groups were given no reward for participation because of high initial interest. While it may be possible that the incentive attracted participants solely for the purpose of

monetary gain, I believe it is highly unlikely that a small sum for an hour's discussion would promote this, and all participants showed keen interest in the discussions.

### **3.3.4 Reviewing qualitative analysis methods**

Qualitative research has become more popular in modern psychology, with increased support from journals and funding councils, and with universities now offering more qualitative courses in psychology degrees (Willig & Stainton-Rogers, 2008a). A range of approaches to qualitative research exist, and it would not be possible to discuss the merits and structure of each method here<sup>9</sup>; instead I will focus on summarising three qualitative techniques highlighted by Starks and Brown-Trinidad (2007). In their paper Starks and Brown-Trinidad (2007) evaluated qualitative methodologies used in health research for personal evaluations and experiences. Though this study has a different focus, the goal of understanding views and thoughts of individuals on social processes and events is similar, and requires methods akin to health research. The three methodologies will to be discussed are Interpretative Phenomenological Analysis (IPA), Discourse Analysis, and Grounded Theory.

One of the more recent advancements in qualitative work, IPA was developed during the mid-1990s (Smith, 1996), and focuses on detailed examination of individual experience of the world and experience (Eatough & Smith, 2008). IPA methodology focuses on individual interviews with participants who have experience of a topic, similar to an idiographic design, carefully evaluating each interview's data before considering the comparisons between interviewees (Eatough & Smith, 2008). A classic example of IPA work is the study of people suffering chronic lower back pain (Osborn & Smith, 1998). This identified the guilt and feared social stigma that sufferers felt: concepts previously missed by conventional correlational research, demonstrating the ability of qualitative work to raise important topics quantitative methods may not identify. With a strong focus on the individual, IPA research often leads to small sample sizes by committing resources to an in-depth understanding of an individual; it is not unusual to have samples of 5-10 participants and it may be possible to have only one participant (Smith, 2004). Texts from interviews are analysed for several different interpretations by the researcher: one example is to view the text in an empathetic and understanding way and report findings, or to critically assess what is said (or not said) and develop a deeper analysis (Eatough & Smith, 2008). Effectively applied in health-research to understand experience of illness (Brocki & Wearden, 2006), IPA is a powerful means of exploring radical and life-changing events in individuals (Eatough & Smith, 2008). However with IPA's focus on individual experiences (and less on the group's understanding)

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<sup>9</sup> For an excellent discussion of qualitative methodologies, written by developers and practitioners of the core methods, see Willig & Stainton-Rogers (2008b)

of a phenomenon (Smith & Eatough, 2007), IPA was seen here as contrary to the goal of understanding wider, general responses to travel mode choice. While it has been argued that an in-depth analysis of individual cases may lead to uncovering “*significant aspects of a shared humanity*” (Smith, 2004, p.43), the strength of IPA lies in its ability to detail an individual’s experience: (Smith, Flowers, & Larkin, 2009). The research question at hand is not the *experience* of using a travel mode, but the motives of travel mode use in the context of carbon reduction targets, and for this reason an IPA approach was rejected.

Secondly, discourse analysis methods, such as Discursive Analysis (Potter & Wetherell, 1987) or Foucauldian Discourse Analysis (see Arribas-Ayllon & Walkerdine, 2008), were considered. Discourse Analysis generally involves the examination of language used by individuals (their discourse) in natural settings to define and construct social roles and identity (Starks & Brown Trinidad, 2007). A cognitive view may suggest a person’s words are reflective of their inner views (assuming they have no reason to lie), while discourse analysis considers the context of the discussion, and how the individual creates a response to suit that context (Willig, 2008a). In her example, Willig (2008a) suggests that when men are interviewed by a female researcher on gender and housework, the men’s responses could be evaluated as reducing a negative view of men as “slobs” (p. 162); not by lying, but presenting responses in a particular reading of the question and context. Discourse analysis is a wide methodology with several schools of thought, though for brevity the two main versions known as Discursive Analysis and Foucauldian Discourse Analysis (Willig, 2008a) will be discussed here.

Discursive Analysis focuses on “talk as action” (Wilkinson, 2000), referring to the idea that talk is constructed for a certain context: not directly reflective of a person’s thoughts or feelings, but indicative of how they construct a meaning in a particular environment. Strict attention is paid to what is said, focusing less on the content, but tracing the discourse to its “action orientation” of what the speech connotes; another example would be a text that gives an impression of an apology without explicit use of “I’m sorry” (Willig, 2008a). Analysis involves reading the text (ideally from a natural setting, but more commonly from semi-structured interviews with participants) as the researcher asks themselves why they read the text in a certain way, and how the text creates this impression (Potter & Wetherell, 1987).

Foucauldian Discourse Analysis takes a different approach. Inspired by Michael Foucault’s post-structuralist ideas, it views discourse as constructing ‘subject positions’: a way of framing oneself in a context that facilitates the appropriate discourse. A common example is discussing health and treatment within a hospital; those who experience illness are defined as ‘the patient’: a passive position open to influence from the ‘doctor’ to facilitate healing (Willig, 2008a). The constructs created in discourse can then be used to understand



experience of the events, as the experience is defined by the construct of oneself and the environment – so the ‘patient’ in our example would be able to discuss their time in hospital through this identity, different than the experience of the ‘doctor’. The motivations and gains of these constructs are then considered: how constructs inform power conflicts between roles and ‘players’, and ramifications of the constructs used: both for the individuals involved and for explaining the actions undertaken.

Applications of discursive analysis include an influential analysis on the construction of culture and racism in New Zealand (Wetherell & Potter, 1992). More relevantly, the method has also been used to explore constructions of car and bus use (Guiver, 2007), and application of discourse analysis has been used in designing psychological interventions (Willig, 1999). The use of discourse analysis can be a useful and illuminating method, but the focus on social identity and construction of relationships moves away from the goal of this study to explore motivations of individuals undertaking a behaviour – it may develop the constructed identity of a travel mode user or constructs of power between different mode users (both of which would be interesting) but not the motivation to use a mode and reaction to environmental concerns which is the focus of this study.

Having examined the above methods for qualitative analysis, it became clear that the most appropriate method for this study would be to use Grounded Theory (Glaser & Strauss, 1967), in particular the so called ‘Glaserian’ approach (Glaser, 1992). To put this into context, and explain the choice of this method, a brief discussion of the history of Grounded Theory and rationale for this method will now be explored.

### **3.3.5 Applying Glaserian Grounded Theory**

Grounded Theory was first described in 1967 by two sociologists, Barney Glaser and Anselm Strauss, who sought an alternative method to the conventional hypothetico-deductive methods predominant at the time. In their attempt to understand the experiences of dying patients, Glaser and Strauss ‘discovered’ a method that allowed them to generate new theories directly from data collected without requiring the testing of previous (and possibly inappropriate) ‘grand’ theories that dominated sociological work at the time: such as the works by Max Weber or Émile Durkheim (Glaser & Strauss, 1967). Their 1967 work challenged the logico-deductive method of developing a theory and seeking data to verify it (Walker & Myrick, 2006). Instead, they outlined how to generate new theories, directly from data, that accounted and explained behaviour<sup>10</sup> (Glaser & Strauss, 1967). A revolutionary approach (Charmaz & Henwood, 2008), Grounded Theory was not widely used when originally developed, but has

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<sup>10</sup> For the rest of this chapter, the use of the word ‘theory’ refers to the qualitative definition, and not the empirical explanation of phenomena more commonly used in scientific literature.

since become one of the most popular methods of social research among many topic areas (Bryant & Charmaz, 2007; Payne, 2007) and is praised as the driving force in establishing the legitimacy of qualitative social methods (Thomas & James, 2006). Since the original publication of Grounded Theory however, the partnership of two researchers split: each favouring a variation of their original work. Though I will cover the differences between these versions of Grounded Theory in more detail, in brief, Strauss and (in a new collaboration with) Corbin suggested a detailed approach to analysis using preconceived concepts to be used, whereas Glaser maintained that prescribed methods reduce the ability to directly generate theory from data.

Despite differences in later versions, Grounded Theory has several core concepts that remain valid across variations. A brief outline of the fundamental steps is given here, with examples of these steps in the Analysis section of this chapter. The core concepts of Grounded Theory, as defined by Charmaz (2008), begin with an immersion of the researcher with the data. From conception of a research question, through to transcribing and writing, the researcher is simultaneously analysing and collecting data. Once some initial data are collected and transcribed, the researcher begins to develop codes and categories from the data, labelling and highlighting within the text where themes and ideas emerge for later use and organising these themes and codes into theoretical categories. Glaser (1978) recommends that the analyst should repeatedly ask themselves three questions when coding data:

1. What is the data a study of? (*i.e. what is being discussed, and has this been discussed before*)
2. What category does this incident indicate? (*i.e. do the data apply to any existing category, or is this possibly a new category*)
3. What is actually happening in the data? (*i.e. what is occurring in the data, what is being discussed, and what does it relate to?*)

Through coding and recording of themes, a framework theory can develop and explain the data. As more data is collected and coded, the researcher engages in constant comparison: a pivotal process of comparing codes, themes and theories against each other to strengthen the validity of the developing theory. As the theory becomes clearer, the researcher aims to collect data that further develops the theory by collecting data from groups with new insights into the behaviour, or to shed light on questions arisen within the theory: a process known as theoretical sampling. As more data is collected from sources that assist the development of the theory, constant comparison between previous and new data helps the researcher to develop the framework theory. Throughout the whole process, the researcher is constantly

recording their thoughts and ideas in ‘memos’ that provide a track record of the thought process and facilitating the constant comparison process.

Though not the intention of this chapter to discuss the schism between Glaser and Strauss, which Walker & Myrick (2006) ably cover in great detail, a brief review of the main disagreements will be explored: the role of prescriptive instructions to undertake Grounded Theory, and of theory either ‘emerging’ or being ‘forced’ from the data (Payne, 2007). The original 1967 publication of Grounded Theory did not offer a clear methodological method for researchers (Payne, 2007). The divide between Glaser and Strauss became apparent with the publication of Strauss and Corbin’s (1990) work that gave researchers a complex and rigid procedure, using several predetermined methods, for analysing the data (Goulding, 1998). In a scathing rebuttal, Glaser (1992) felt these detailed methods broke away from Grounded Theory and the central tenet of ‘constant comparison’ – comparing each individual code developed from the data against previous codes – arguing that the complexity of Strauss and Corbin’s approach interferes with the process of ‘discovering’ a new theory (Willig, 2008b). The idea of ‘discovering’ a theory, or having it ‘emerge’ from the data is fundamental to Glaser’s approach and the simplicity of constant comparison allows the data to “*speak for itself*” (Glaser, 1992 p.123). For Glaser, the Strauss and Corbin method forces preconceived ideas upon the data to accommodate the analytic tools they prescribe to researchers. As noted by Walker and Myrick (2006), although Strauss & Corbin offer analysts a detailed guide, their use of preconceived instructions removes “*true emergence*” of theory (p. 556).

The two variants of Grounded Theory discussed here are the original applications of the theory, though the rise of qualitative methods in recent years has led to an incredible range of approaches within qualitative methods – and Grounded Theory has expanded with these developments (Bryant & Charmaz, 2007). The variety of Grounded Theory applications is beyond the scope of this chapter and includes (but certainly not limited to): Feminist (Wuest, 1995); Constructivist (Charmaz, 2006); Postmodernist (Clarke, 2005) and Post-Positivist (Kennedy & Lingard, 2006) perspectives, each with their own intricacies (Bryant & Charmaz, 2007). With so many applications available, selecting the appropriate method is challenging. However, considering the differences underpinning the different views of Grounded Theory, I argue that the original, ‘Glaserian’, school of thought is the most appropriate methodology to employ for this particular research question. There are two main justifications for Grounded Theory analysis using Glaser’s approach: the practice of true emergence, and the positivist position it can support – two concepts in Grounded Theory that I will now describe and highlight the importance of.

First, there is limited existing research in the area – there are no similar qualitative explorations that compare several travel mode choices. One analysis (Gardner & Abraham,

2007) explored motivations for car-use using Grounded Theory, but failed to develop an explanatory theory: instead offering “theoretical proposals” (p. 198) highlighting motivations for car travel with no unifying theory. Also, current research has focused on individual groups or opposition between two groups of mode users (e.g., Beirao & Cabral, 2007; Daley & Rissel, 2011; Darker et al., 2007). The current analysis seeks to explore travel choice and carbon emissions by comparing the experiences and views of people across a variety of travel modes. This is an ideal opportunity for Grounded Theory: developing new theory in areas of little research is where Grounded Theory becomes most appropriate (Bryant & Charmaz, 2007; Punch & Punch, 2005). Considering the lack of previous studies the Glaserian approach may be, in effect, more grounded in the data, compared to the Straussian approach (Bryant & Charmaz, 2007). In order to base further work on the findings of this study, I am compelled to use a methodology that directly builds upon the collected data.

Secondly, the epistemological position of qualitative methods must be considered, especially with the intended mix of quantitative and qualitative research within this thesis. The debate between qualitative and quantitative approaches has previously been a contested issue with heated debate between researchers committed to their methods (Johnson & Onwuegbuzie, 2004). The basic divide between the philosophies of qualitative and quantitative methods, however, has been challenged (Adamson, 2006; Denzin, 2008). There is a growing support for developing mixed-methods research, since the key is the research question itself, and not the means to investigate it (Tashakkori & Teddlie, 2010). The current study wishes to use the exploratory strengths of qualitative research (Murphy et al., 1998) in such a way that new ideas may later be validated through empirical research. The reason for such an approach is to maximise the potential applicability, and hopefully benefit, that the research may hold. To this end, a more positivist approach was sought, which should more easily transfer findings to a later quantitative testing.

In its purest form, positivism involves the idea of universal ‘truths’ that can be found through scientific means, against the ideas of interpretivist or constructionist views, and the term is commonly used to describe empirical measures of psychological research (Willig & Stainton-Rogers, 2008a). Of the main ‘schools’ of Grounded Theory, the Glaserian approach follows a more positivist route (Charmaz, 2000) than, for example, the reflexologies of the post-positivist (Denscombe, 2010) or constructionist perspectives (Pidgeon, 1996). In fact, Grounded Theory has been highlighted as a potential ‘bridge’ between traditional quantitative and recent interpretative epistemologies (Charmaz, 1996, 2008; Charmaz & Henwood, 2008). This is not to say that non-positivist views and methods are without practical application (e.g. Willig, 1999). But the current research aim is not just to understand a small sample’s views on transport and carbon emissions, but to explore a broad and fundamental characteristic of

travel behaviour which may assist broader quantitative work: a goal that Grounded Theory is suitable for (Charmaz, 1996). Appealing to a more positivist view can be a controversial position in qualitative research, where positivist labels used in discussion “*constitutes an insult*” (p.3, Willig, 2008b). Nonetheless I hope to have laid clear my belief in using Glaser’s Grounded Theory to support my research.

### 3.3.6 Analysis

Transcripts of the focus groups can be found in Appendix A of this thesis. Analysis followed suggestions and methodology outlined by Glaser and Strauss (1967) and Glaser (1978, 1992). It can be difficult to outline in clear and concise terms the steps involved with Grounded Theory research; from collecting data to a final theory grounded, the process is iterative as steps can ‘blend’ and be taken in different orders (Pidgeon & Henwood, 1996). With that caveat, a brief description of the methodology employed by this study will now follow.

The first step of analysis involved reading the transcripts several times to become familiar with the text. Once fully acquainted, Glaser outlines coding (recording and highlighting salient points and themes in the text) in two steps: substantive and theoretical (Glaser, 1978). Substantive coding is the practice of working through the text, coding items with straightforward and often *in vivo* (from the data) terms, ideally coding line-by-line (Willig, 2008b). For example, one participant discussed a fear that management may not be fully committed to CO<sub>2</sub> reduction – this was given the code ‘*Management not serious about CO<sub>2</sub> reduction*’, and was used for similar views from other participants. Coding individual items allows the emergence of a category: a unifying principle that explains the actions and views developed from participants’ discourse. Categories emerge through the practice of *constant comparison*, a defining characteristic of Grounded Theory. After identifying individual codes, and constantly comparing them to previously identified codes, patterns that show conceptual links allowing emergence of categories (Glaser, 1992, p. 49). As an example of constant comparison, the codes ‘*Management not serious about CO<sub>2</sub> reduction*’, ‘*Image of management considering green issues*’ and ‘*Management divide between action and instruction*’ were grouped together to form the category ‘*Greenwashing*’: covering discussions of management seeking an environmentally-friendly image without actively pursuing environmentally-friendly policies. Constant comparison allows these new categories to become more coherent, each with several individual codes and meanings included.

Once categories have been developed, the second coding stage began. Defined as *Theoretical Coding*, analysis focused on how categories interlink (through constant comparison) into a larger framework to explain the data. Categories often went through several changes, with codes removed and placed into new categories that newly emerged from the data. As categories evolved, three main themes emerged under a single explanatory

grounded theory. Eventually a point was reached where new data no longer introduced new concepts, but supported previously determined concepts – a state called *saturation* that signals the end of the coding exercise. This point was reached during the coding of the walking focus group.

Parallel throughout the analysis process is the constant writing of *memos*: ideas on the categories, themes and relationships between codes ideally captured “*in a stream of consciousness*”<sup>11</sup> as an idea emerges. Memos are vital in Grounded Theory, a method of capturing intricate complexities of the data when emerged in the coding process. When saturation was reached, analysis was written by combining memos produced, and integrating the categories into a grounded theory. Even during this period of writing up, constant comparison continued to explore links within the data, refining categories and theory.

### 3.4 Findings

A range of views, praise, and critiques of transport topics were collected, and each group exhibited unique characteristics. To give a brief profile of the groups, bicyclists displayed strong environmental awareness with a desire for pro-environmental action; though were cautious of management not taking issues seriously. Valuing speed, physical activity and nature, bicyclists expressed understanding of car use but felt that preconceptions to alternative modes were barriers to reducing car use and increased bicycling. Walkers held similar views to bicyclists, showing solidarity on environmental beliefs, though rejected bicycling for safety reasons, and embraced the simpler and more relaxing mode of walking. Car users expressed some environmental concern and recognised themselves as targets for change: but each felt that their individual driving was justified and required incentivisation for change. Though some support for using other modes existed, car users were wary of other modes and resented interference in their behaviour. Motorcyclists, similar to car users, held strongly to the concept of personal freedom: limited interference from management, understanding personal context and the need for gentle persuasion were key issues. With limited environmental concern, motorcyclists embraced riding as a source of excitement. Lastly, bus users displayed small levels of environmental concern, and were mainly focused on the issues present within bus use, showing low satisfaction and yet a limited desire to consider other travel modes.

Through individual coding of transcripts, the constant comparison method, and reviewing memos, analysis led to the formation of three key discussion themes;

1. Carbon reduction and transport
2. Changing travel mode

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<sup>11</sup> Obtained online from <http://www.groundedtheory.com/what-is-gt.aspx> on 20th July 2011

### 3. Own travel mode choice

The three themes reflect views extending from large-scale issues (such as general CO<sub>2</sub> targets), down to reviewing possible behaviour change strategies, and finally on the instrumental and affective experience of one's own travel mode. Reviewing these themes further, a clear common topic emergent amongst all users' discussions was the general need for autonomy: the ability to make a choice that granted the individual a feeling of control over their travel. This general desire for autonomy forms the overarching Theory generated from the data. Accordingly, each of the three main themes will be discussed to demonstrate how, in each of the areas of discussion, mode user groups contrasted and agreed upon discussions of climate change and transport, and how the central theme of autonomy emerged in each area. Throughout this analysis, paraphrased sections and short quotes will be referenced back to the original transcript and line, such as: (Car: 217), and larger verbatim quotes are shown where particularly illuminating, and include the quote source and assigned pseudonym.

#### 3.4.1 Theme 1: Carbon Reduction and Transport

Though arguably having a greater contribution to carbon emissions than other modes, car users expressed general support for a "green future" (Car: 9), and motorcyclists similarly understood and accepted the need to reduce emissions (Motorcycle: 8-9). But despite these general claims of support, car users were strongly critical towards several aspects of the recent workplace carbon reduction target: questioning its accuracy (Car: 15) and perceived lack of consultation with travel mode user groups:

*(Car: 38-39) Josh: "I have no idea where [the target] came from they never asked me, I don't understand the rationale for it at all"*

Application of the target also became contentious, with fears that car users would become an easy target for management's policies (Car: 49). Similarly, motorcyclists were somewhat in favour of reducing CO<sub>2</sub>, and the target more specifically, but again were more concerned with the effect on individuals:

*(Motorcycle: 16-19) Ben: "...I agree I think the university has to look at all ways of to reduce it, so the carbon footprint with energy management and also this, transport, trying to encourage people to travel to and from the university in the most, economical, and convenient way for the individual"*

Such responses based on concern and suspicion of the target amongst motorists contrast with the supportive and welcoming views from walkers (Walking: 6) and bicyclists (Bicycling1: 7-9), who not only didn't question the target itself, but also went further, wondering whether the

target included all emission sources to fulfil the target's goal (Bicycling2: 16-17). Car and motorcycle users named several alternative areas for reducing carbon, rather than changing their own travel behaviours. Electricity and building emissions were a source of contention, as they felt that any efforts to change travel mode away from motorised forms would be overshadowed by, and make little difference because of, far greater energy losses in the workplace (Motorcycle: 909-924; Car 1037-1038). A recurring phrase for motorcyclists (Motorcycle: 909) and car users (Car: 239) was 'joined-up thinking': a need for collaboration to reduce emissions across different areas before tackling travel mode choice, perhaps as a means to further distance themselves from forced change by highlighting another area for targeting. Excess electricity use and heat loss through improper insulation were also concerns for active mode users (walkers and bicyclists), but for different reasons. With a more positive attitude towards reducing emissions than car users, issues with wastage were raised by walkers (Walking: 398-400) and bicyclists (Bicycling1: 61-63) partly out of their greater environmental concern, but also from resentment that energy loss through buildings undermined the carbon savings they had made through their low-carbon travel behaviours:

*(Walking: 195-199) Emma: "...but also there's a part of me that thinks why should we help... why should we help the university reduce their carbon footprint because they've been... have been coming around the department... looking at where they could put big, TV screens up"*

Building on the discussions of suitable areas for reducing emissions, groups were unified in their contempt for false action to reduce environmental damage: described by car users as actions performed "ostentatiously" (Car: 117), and as a "PR stunt" (Car: 138) to achieve a desirable public image (Car: 21-25), rather than real reductions in carbon emissions. Participants voiced concern about this topic by using the phrase 'Greenwashing', as illustrated by this bicyclist:

*(Bicycling 1:9-12) Scott: "No, I think it's bullshit, its greenwash, they're just building new car parks; they do nothing to discourage people driving by car it's just, um what's the word?" (Mark: "It's a ruse") Scott: "Yeah, it's a ruse, yeah"*

Building on the deceptive connotations of the word "ruse", others described a belief that actions may be taken as a risible "token" (Bicycling2: 24), or "lip service" (Walking: 360) which fails to support active modes (Bicycling2: 835-838) or neglects the environmental impact (Walking: 398-403). All groups disliked the false nature of greenwashing and identified real or possible examples, but their displeasure stemmed from different reasons. Active mode users were annoyed that their efforts to reduce carbon dioxide emissions were



overshadowed by wasted electricity (Walking: 195-200), whereas other mode groups were cautious of changing their behaviour to reduce emissions (effectively making “sacrifices”, as some might see it) if others didn’t have to change as well:

*(Car: 178-179) Anne: “But then if it was, y’know, turn it around and they’re asking other staff members to do it and they’re not doing it, how would you feel about that?”*

### **3.4.2 Theme 2: Changing Travel Mode**

The practicalities of choosing to change travel mode choice to reduce carbon emissions was considered: although some were optimistic that change to reduce carbon emissions was possible (Bicycling1: 77-79), the majority of participants recognised the difficulty in changing car users’ behaviour (Bicycling2: 497-501; Bus: 14-14). Groups felt there were many physical and contextual “reasons” (Motorcycle: 758-759) or “excuses” (Bicycling2: 298-299) that car users would struggle to overcome; these were also frequently discussed by car users themselves, who felt powerless to change, driving to work “because we have to” (Car: 206). The rationale for this was usually tied to living locations and their perceived distances from the workplace (Car: 305-308). In fact, car users described a lack of awareness when it came to alternative modes and how they could actually be used:

*(Car: 343) Chloe: “. . . I have no idea what the footpaths are, up to the university. . .*

But as well as the instrumental issues mentioned by car users (distance, cost, time), non-car users felt there were psychological barriers blocking travel mode change in those who usually drive. They described beliefs that car use had become routine or habitual (Walking: 105-107), and that car users had deeply-ingrained prejudices against alternative modes:

*(Bicycle1: 40-45) Mark: “...[At other workplaces] there’s been more of a move to persuading people to take buses, or to walk, or to cycle...whereas here it’s just a foregone conclusion, it has to be crazy to cycle or even walk up the hill, and it’s just accepted”*

Non-car users (Bus: 189-190; Motorcycle: 282-284; Bicycling1: 144-146) also felt social norms encourage people into cars, and cultural shifts would be needed for change to occur in drivers, highlighted by a bicyclist when discussing bus improvements:

*(Bicycling2: 829-830) Tom: “...that of course does move a little bit away from perhaps the cultural change that needs to go on, along, alongside that to get people out of cars, y’know”*

The situation was not seen as static, however: participants felt that wider context changes, such as rising fuel costs, may eventually force people into change (Bicycling1: 743-746). This idea was particularly voiced by the motorcyclists, who suggested that economics and rising fuel costs could encourage behaviour change without impeding personal choice:

*(Motorcycle: 492-493) Ben: “maybe we don’t need to have it university-led... maybe we just let economics lead... which is what it’s doing now”*

For change to occur, groups were also in favour of upper management “*leading by example*” (Motorcycle: 403; Walking: 242), clarified by one bus user:

*(Bus: 113-119) Fay: “... it’s only hypothetical but I think that’s the best way, like to cause a reaction because if you’re sort of, trying to promote policies then it has to come from the top down I think to be taken... seriously”*

Again there was a split between the groups in how this was viewed. Car users supported the idea of leadership on mode change (Car: 151), but voiced unease about how this could be accomplished. Having senior management use sustainable modes was seen as potentially wasting time and money (Car: 152-155). One car user remarked that “*the devil would be in the detail*” (Car: 176-177) and others worried about the precedent that may be set for future employees:

*(Car: 159-163) Sean: “Would it become a requirement of taking the job? That’s the next question, y’know, “We think you’re the ideal candidate but unfortunately you’re going to have to get rid of your car and get a bike... otherwise you can’t get the job...”*

Bicyclists, on the other hand, felt leadership could help with public perceptions of ‘green’ travel modes being associated with low social standing (Bicycling2: 212), but expressed strong scepticism that it may fall back into Greenwash with ineffective changes made (Bicycling2: 180; Bicycling1: 149-155). Discussion of whether travel mode change was actually possible often led to the wider question of whether it was legitimate to influence a personal choice outside of the work environment. Car and motorcycle users directly questioned the right of management to influence this aspect of their lives:

*(Motorcycle: 28-30) Alex: “...the question is, to what extent the university should play a role in, having, their employees change their behaviour, because that’s really the question”*

This threat of management “*impinging*” (Motorcycle: 480-481) on several areas of personal life was echoed by car users disliking management’s perceived “*interference*” in their personal lives (Car: 419-421), as well as viewing personal choices in location and travel as “none of [*management’s*] *business*” (Car: 301-302) and management being “*abusive*” (Car: 312) in changing travel behaviour. In contrast, active mode users encouraged influencing modal choice without any discussion of the validity of doing so; instead they felt management should be *more* proactive in changing people’s behaviour (Bicycling2: 49-50). But active mode users did not go so far as supporting enforced change; rather, they felt management should be encouraging, not dictating, people towards more sustainable modes:

*(Walking: 282-286) Lily: “But I guess if it was linked to something positive like helping the environment or helping their fitness or whatever... then maybe it wouldn’t feel like a punishment it would just feel like an active choice they were making to moving towards something positive”*

This recognition of the need to respect individual choice and autonomy was also evident in how walkers (Walking: 720-723) and bicyclists wanted people to try their modes to overcome preconceptions:

*(Bicycling1: 948-950) Jim: “...but that’s a mental thing and y’know, I’m not going to start to try to break my friends into it, but what I am trying to do is just, demonstrate that it’s, you can have a go, and get a good idea yourself, y’know it’s just all about awareness”*

In contrast to all other groups, car users repeatedly described how they wanted material incentives or benefits before they would consider changing their behaviour (Car: 257-258; 524; 543). Though car users begrudgingly accepted that car-use reduction could occur in limited circumstances (Car: 468-460), they individually continued to distance themselves from change. Even while insisting that incentives were necessary, they suggested that whilst there was a sub-section of car users who would be able to reduce their driving, they themselves did not fall into this group:

*(Car: 305-312) Sean: “...let’s say someone lives within a mile of the university and drives... you can incentivise them... in a way that isn’t being abusive that’s my point really “*

Finally, a point made repeatedly when discussing other modes concerned how they were viewed as offering less control over one’s journey compared to each participant’s current mode. Whilst it was generally agreed (Bicycling2: 502-504; Walking 767-768) – even by car

users themselves – that the bus was the logical alternative to the car (Car: 459; 472-473), car users were strongly against using the bus themselves. The cost of buses was variously described by drivers as “*incredibly*” (Car: 521), “*exorbitantly*” (Car: 539) and “*shockingly*” expensive (Car: 1225). Those with some experience of using the bus had similarly strong impressions of dealing with strangers “*squeezed up next to you*” (Car: 1105) and a perceived risk of catching germs (Car: 1106). In particular, the idea of using the bus was largely rejected by car users for the loss of control compared to car use – with regard both to journey time (Car: 505-506), not knowing when the bus would arrive and whether it would have free seats (Car: 549-552), and lacking control over one’s immediate surroundings (having to mix with strangers).

The fear of losing control and autonomy by changing travel mode wasn’t limited to car users; bicyclists similarly felt cars prevented people from experiencing the open world, trapping them “*in a little box*” (Bicycling1: 833-835) to be frustrated by traffic over which one had no control:

*(Bicycling 1:732-736) Mark: “...but people just don’t want to give up their... perceived freedom... but often it isn’t freedom, it’s entrapment”*

Yet whilst regular bicyclists felt their mode offered them freedom, bicycling was framed by other groups as a dangerous activity; some car users expressed interest in bicycling but were held back by safety concerns (Car: 377), feeling that bicycling was “*lethal*” (Car: 1049). Discussion from walkers similarly showed a perception of stress and danger in bicycling, particularly with the absence of segregation from motorists:

*(Walking: 641-646) Sue: “...it’s pretty stressful and you’re in a completely different environment once you step out off the pavement... onto that black tarmac it’s like a different world really”*

The time taken for showers and the lower speed of bicycling compared to driving were cited by car users as additional ways in which control might be lost, suggesting it was “*pure luck*” how long it would take to bicycle to work (Car: 380). The general applicability of bicycling was doubted by many non-bicyclists: bicycling would always be for a “*minority*” (Car: 620), estimated at an upper limit of “*only fifteen percent*” of the population that could cycle (Motorcycle: 557-558).

As for walking, car users showed some positive views about the possibility of walking: “*if we could walk to work easily we would*” (Car: 261). But interest in walking as a means of transport was far from universal amongst the car users. In one rather extreme statement:

*(Car: 1214-1215) Josh: "Anything else is Third World, asking me to walk five miles to and from work it's ludicrous it's never going to happen"*

### **3.4.3 Theme 3: Own Travel Mode Choice**

When people discussed their own current modes, groups largely focused on enjoyment. Bicyclists' enjoyment stemmed from physical exercise giving a *"very accomplished feeling"* (Cycling1: 772-776), being outdoors in nature (Cycling2:949-950), and experiencing positive mental effects on mood (Cycling1: 804-805) and thinking time (Cycling2: 946). Walkers were similar to bicyclists: a strong appreciation for nature (Walking: 943), fitness (Walking: 67-68), and mental health (Walking: 872) ran through both groups' discussions of positive motivation. Walkers additionally expressed satisfaction with their mode because of its simplicity: bicycling required external machinery while walking did not, and was therefore easier:

*(Walking: 849-850) Emma: "... I don't think we need, I mean you just walk"*

*Sue: "Mhmm, mhmm I don't think we really need anything"*

For motorcyclists, the most popular reason for commuting by bike was the affective thrill and excitement of motorcycling:

*(Motorcycle: 961-964) Dave: "From my point of view, every time I get on the bike I get a buzz just thinking 'Ah I'm just going out on the bike' y'know... It's, it's in the blood"*

Car users enjoyed the time their journey offered, giving a chance to clear their heads (Car: 1122), to drive through nature (Car: 1092) and start their day afresh (Car: 1094). The social aspect of car-sharing was praised (Car: 1098-1100), with the caveat that the person they car-shared with must be familiar and not a stranger (Car: 1105). The clearest indication of enjoyment for car use was in discussions of freedom and the love of driving:

*(Car: 1294) Zoe: "I'd give up food, yeah, to carry on driving, I would"*

These favourable views are in stark contrast with the experience of bus users who discussed this theme of enjoyment and autonomy purely through its absence. Described by one participant as *"deeply unsatisfying"* (Bus: 656), bus journey descriptions were uniformly negative with various issues raised, including the cold (Bus: 211), the smell (Bus: 208-210), other people (Bus: 699), ticket costs (Bus: 874), and time involved (Bus: 796-797). Whereas, as described above, users of all other modes felt they currently had control over their journeys and would lose this if they switched to another mode, bus users were unique in feeling they had limited control over their present journey: they felt buses ran to the driver's timetable and

not their own (Bus: 284), without knowing for certainty when buses would arrive (Bus: 469). They sometimes watched full buses drive pass without stopping (Bus: 272), and had problems with journey lengths varying considerably from day to day (Bus: 170-171), experiencing particular frustration when stuck inside a bus that was running late (Bus: 277). Discussions of the cold, smell and proximity to other people also highlighted a lack of control over their surrounding environment. Bus users described themselves as a “*captive audience*” (Bus: 943-945), unable to enact change or influence the problems they faced.

Objectively, car users are just as helpless as bus users when stuck in traffic. It is therefore interesting that car users described how they could regain a sense of control through predicting traffic issues or engaging in a form of displacement activity:

*(Car: 1118-1121) Anne: “I know they’re there, yeah” (Josh: “-I find it very predictable”)*

*Anne: “You’ve got the radio on so you’re used to it, sit back I forget all about it so, yeah no it’s fine”*

Bus users, in contrast, didn’t have this coping mechanism - uncertainty about their trips made it impossible to predict and control the situation. In fact, discussions from bus users contained several instances where they had tried and failed to gain control:

*(Bus: 891-893) Fay: “You put your foot down and you just say ‘Nah I’m going to wait’ but then, you just wait for ages, sometimes I’m like ‘No I’m not going to get [another bus], I’ve paid for this bus pass’, but then you just end up waiting so long”*

Even attempts to take control by walking short distances to other, less busy, bus stops further along the route failed because buses were full by the time they arrived (Bus: 241-242). Experiences reported by bus users almost suggest a kind of learned helplessness (Maier & Seligman, 1976): an absence of power over their circumstance, where their efforts to regain control have always foundered, which leads to dissatisfaction but also an unwillingness to change mode. Bus user’s views stand in dramatic contrast to the users of other modes, who, as mentioned above, often discussed their feelings of control and the benefits these brought. One bicyclist summarised the control he perceived in his chosen mode thus:

*(Cycling1: 833-835) Scott: “...if you get anything in front of the cyclist you can either overtake it or get off and push it or whatever, you’re not caught up by things, and the frustration is just not there”*

### **3.5 Discussion**

An emergent Grounded Theory analysis was applied to focus group discussions from users of five different travel modes, who each travelled to the same place, discussing modal choice in the context of CO<sub>2</sub> reduction. Analysis showed that car and motorcycle users were apprehensive about the threat of carbon emissions being used to force travel mode change and questioned whether management held authority to change a personal choice. Walkers and bicyclists were united in their greater concern about carbon emissions, but recognised the need for a careful approach to encourage and not dictate the use of sustainable travel modes. Notably, whatever travel mode a person currently used, they worried they would lose control and autonomy if they switched, and promoted their current mode for its ability to overcome obstacles, suggesting a close relationship between perceptions of autonomy/control on the one hand and satisfaction on the other. This relationship was further supported by the negative case of bus users, who expressed strong displeasure with their journeys arising from their inability to predict, control, or have influence over them. Analysis highlighted three broad areas of discussion; the wider context of CO<sub>2</sub> and carbon targets, the application and legitimacy of changing travel behaviour, and the instrumental and affective motives for their travel mode choice. Grounded Theory analysis approach led to an exploratory Theory: travel mode choice reflects a desire for personal autonomy, and efforts to change mode choice must reflect this.

#### **3.5.1 Emergent theme of Autonomy**

With an original aim of exploring concerns for carbon emissions and travel mode choice, a surprising finding was that discussions of emissions and mode choice were so strongly linked to personal autonomy. Participants framed their mode choice in terms of experienced autonomy, were uninterested in other modes for a perceived lack of autonomy available, and were deeply concerned that behaviour change would impede on personal choice. The importance of freedom and autonomy in car use is mentioned by other qualitative reports (Chatterton et al., 2009; Ellaway et al., 2003; Gardner & Abraham, 2007; Hiscock et al., 2002; Mann & Abraham, 2006). Additionally, some quantitative reports have highlighted the importance of freedom and control for car use (Steg, 2005), and the dissatisfaction of car use linked to loss of autonomy (Ettema, Gärling, Olsson, Friman, & Moerdijk, 2013). Other modes of travel have also been linked to a need for autonomy, including cycling (Daley & Rissel, 2011) or the loss of control when using public transport (Beirao & Cabral, 2007). It is interesting that the current results highlighted the lack of control felt when using the bus, while other modes reported positive experience. Some exploratory quantitative work supports this finding, with a comparison of car users, bicyclists, walkers, and bus users indicating that

the experienced sense of control on a daily commute was significantly lower for bus users than other modes (Anable & Gatersleben, 2005).

This is the first time that autonomy has been explored in such a tightly matched qualitative design, where people travelling to the same workplace using different modes were compared. The fact that it emerged as a common thread when people were ostensibly discussing carbon emissions gives additional weight to the importance of autonomy when considering modal maintenance and the how mode change might be difficult to effect. The importance of autonomy in daily life is linked to increased well-being and happiness (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000) and travel mode choice may also be viewed as a hierarchy of instrumental, then affective, then aesthetic needs of travel (Musselwhite & Haddad, 2010). The emergence of autonomy as a key theme in a discussion that was originally about carbon reduction also illustrates the strength of qualitative methods, with their capacity to allow the unforeseen to emerge, for working in areas like this.

### **3.5.2 Behaviour change and the fear of losing autonomy**

This chapter highlights, for the first time, how users of all modes (except the bus) not only felt their mode gave them high levels of autonomy, but also feared losing this if they changed mode. Influencing travel behaviour can be a source of high contention (Tertoolen et al., 1998). Methods for change are judged for their capacity for fairness and protection of individual freedom (Eriksson, Garvill, & Nordlund, 2006; Steg & Schuitema, 2007), with such views clearly evident here in the concerns of those targeted for change (car users), but also shown by those wishing to promote their own modes to a wider audience without being coercive (bicyclists and walkers). This illustration of how important autonomy is within travel mode choice shows how caution must be taken in future interventions. Indeed, the general impression from car users suggested strong perceptions of persecution; they were found to challenge targets and authority, dismissed efforts to encourage behaviour change, expected incentives for change, separated themselves as being the group most unable to change, and identified car use as the only possible choice open to them. Recognising themselves as the likely target, it appears the car drivers in this study had bunkered down to resist any form of change.

To tackle the problem of car users' resistance to change, and their need for incentives, the importance of autonomy across modes may present a solution. Car advertisements often use emotive appeals rather than instrumental application to advertise cars (Bayley, Emerson & Wright, 2009). As reported by Chatterton et al. (2009), car use is linked to the perception of freedom, and any attempts to reduce the perceived autonomy linked to car use would likely be resisted – an idea supported by the current study. Efforts to reduce car use, then, are likely to work better if alternative modes are promoted as sources of greater autonomy. Anticipation of



regret from a decision (e.g., anticipated loss of autonomy) is a powerful influence upon behaviour (Kaiser, 2006; Ravis, Sheeran, & Armitage, 2009), and drawing on Kahneman and Tversky's (1979) Prospect Theory, anticipated regret leads to more conservative actions (Mellers & McGraw, 2001) while building support for the idea that current behaviours are acceptable, even if alternatives could be beneficial (Anderson, 2003). Given that the bus was seen as the most logical alternative to the car in this study, even by car users themselves, it is likely that a shift to the bus might best be aided by infrastructure improvements to remove uncertainty from these journeys, thereby boosting perceptions of autonomy. Live updates of arrival times for public transport have been linked to reduced stress and lower perceived waiting times (Schweiger, 2003), as well as increased feelings of security and control (SAIC, 2003). Dedicated bus lanes are another infrastructural mechanism that might remove journey time uncertainty and so reduce feelings of lacking control, thereby making changes from car to bus more likely to take place.

Alternatively, interventions could promote the autonomy reported within active travel modes as a viable option. Walkers and bicyclists in this study reported high levels of autonomy from flexible route-taking, lack of congestion and other time constraints, which lead to highly predictable journey times. Despite car users' objections of distance, safety, and the apparent "third world" nature of active travel, it may be possible to overcome what some participants described as psychological "barriers" against active travel through autonomy promotion. Public transport advertisements using messages of fun and convenience are known to be memorable (Kenyon & Lyons, 2003), and the positive evaluations in the current analysis could provide a basis for advertising strategies. An additional finding was the lack of awareness of how other modes may be used – exemplified by the lack of knowledge of one car user on how to walk to the university. To promote active modes, trial schemes (as suggested by some bicyclists) could be run to encourage use and awareness of active modes, alongside autonomy-based messages. A review of effective sustainability promotions indicates that using "block leaders" to demonstrate and encourage behaviours was one of the most powerful methods of encouraging change (Abrahamse & Steg, 2013), and the same may be applied to travel. Programs such as 'CyclingBuddy.com' offers local knowledge and support for those starting cycling, and other programs may be developed for walking to alleviate concerns of route knowledge, while giving encouragement to new mode changers.

### **3.5.3 Conflict between environmental concern and environmental action**

Only briefly discussed in some qualitative reports (Beirao & Cabral, 2007; Chatterton et al., 2009; Darker et al., 2007), this analysis is the first to explore views on climate change and travel mode choice. The analysis showed that when asked to consider carbon reduction through transport mode change, people were fond of discussing other, larger sources of

emissions. There are two apparent motives for this: as a defence mechanism to justify continued driving or motorcycling (as Chatterton et al., 2009, also suggested), and, amongst users of low-carbon modes, as a critique of how their own carbon savings are not supported by wider institutional action. Though car users saw their travel mode choice as essential (again in accord with Chatterton et al.), the results here also show that non-car users described such behaviour either as a set of ‘excuses’ or as part of deeper psychological (habitual) or cultural influences upon behaviour. A new element to emerge here was the apparent difference in environmental concern and discussions of carbon among groups, despite all groups declaring understanding of environmental issues. For car drivers and motorcyclists, emission targets were a challenge to their behaviour to be attacked, while other groups saw opportunities for reducing waste as a productive aspect, and encouraged more efforts to reduce unsustainable travel modes.

The divide in views on environmental actions may reflect a difference in environmental views relating to travel mode choice, possibly with active travel mode users having stronger pro-environmental attitudes. Stereotypes of ‘green’ bicyclists have emerged in other reports (Daley & Rissel, 2011; Gatersleben & Haddad, 2010), and may well reflect current views from bicyclists, but there is less certainty over how travel mode is linked to environmental concern. There are no detailed comparisons of environmental concern by travel mode groups (Flamm, 2009), and the link between environmental concern and car use remains uncertain (Gardner & Abraham, 2008; Steg & Vlek, 2009). With the difference in views on environmental action, future research may explore how views on the environment may vary across mode choice.

### **3.5.4 Evaluating the study design**

This analysis is unique in using a qualitative approach to compare several travel mode user groups. For this purpose, the choice was made to use homogenous groups of each travel mode. Several theorists have promoted the practice of homogenous groups in focus group research to facilitate the analysis of the group as a single unit (Barbour, 2007; Smithson, 2008). Homogeneity of group members facilitates a social interaction for participants to make sense of a topic (Smithson, 2008) while encouraging group dynamics and interaction (Stewart et al., 2007) and allowing greater depth of discussions (Bloor et al., 2001). Creating groups with similar members may encourage consensus within a group, but it may also leave more controversial topics unspoken. Focus groups that include dissenting opinions can lead to a “teasing” out of opinions that may otherwise not emerge, and lead to greater understanding through comparative debate (Bloor et al., 2001, p. 6). Groups often created consensus in their views, and while some expressed dissent (as mentioned in the analysis), the main aim was to understand group decisions. Holding focus groups with a mix of mode users may uncover

more detail into motivations of mode users by using challenging discussions: for example, how car users and bicyclists discuss travel distances or carbon reduction policies, or whether bicyclists and walkers may disagree on environmental policies despite their apparent similarities.

The participant sample was recruited from University of Bath staff and students, which also offers some degree of compatibility between participant socioeconomic statuses and interests, which improves group cohesion and discussions (Stewart et al., 2007). But like group structure, the use of one set of participants may limit the breadth of discussion topics. Research from the UK's Department for Transport (Thornton, Bunt, Dalziel, & Simon, 2010) indicates substantial differences between socio-economic groups on the attractiveness of cars versus bicycling as travel modes, and how credibly the threat of global warming is perceived. Focus groups do not generate results that are generalisable to wider populations (Barbour, 2007; Stewart et al., 2007), but extending the research presented here to include additional demographics would be useful for testing the theory presented here.

Though applying focus group results to a wider audience is not possible, focus-group criticism is often based upon the limited number of participants used (Stewart et al., 2007). Qualitative research is concerned more with the value of the data collected, than the number of participants, as a small sample can yield more complex and interesting data (Smithson, 2008). There is no "magic number" (Barbour, 2007, p. 60) for how large focus groups must be, and reflecting on the current sample that used groups of 3 people, researchers have supported the use of groups as low as 3 to provide new and valuable insights (Barbour, 2007; Bloor et al., 2001). It has been suggested that small groups can lead to limited discussion depth and variety making analysis difficult (Bloor et al., 2001), and while data in the current study proved fruitful, expanding group sizes may increase topic discussion. A second concern for sample size within qualitative work is the risk of 'outliers': people with extreme views that may be over-represented in smaller samples. People who agree to travel and take time out of daily life to attend an extended and public conversation on a topic may have strong views (Stewart et al., 2007) that could skew results. Yet it has been argued that such 'outliers' should be sought out and integrated, especially for focus group work, to develop the richness of the data through bold discussion points (Barbour, 2007). Ultimately, with a rich and varied dataset observed, more participants and viewpoints would likely be beneficial for the research, but are by no means a necessity.

### **3.6 Conclusions**

In conclusion, this chapter presents a novel exploration of carbon and travel mode choice across users of several travel modes making regular commuting journeys to the same workplace. Group differences became apparent: car and motorcycle users felt apprehensive

about carbon-reduction targets, whereas users of sustainable travel modes showed cautious optimism. Travel mode change was seen as possible, but all were careful not to deny autonomy in changing behaviour. Whether people walked, bicycled, drove a car or rode a motorcycle, they felt they currently had autonomy and would lose this – and as a result experience less journey satisfaction – if they changed to any other mode. This relationship between travel mode, autonomy and satisfaction is a potentially important area for further research and insights from exploring this relationship might allow the creation of better transport-mode-change interventions which specifically target satisfaction and perceptions of control – not least by alleviating motorists' fear of losing autonomy if they were to switch to more sustainable modes.



## **Chapter 4: Exploratory Survey Work: Quantifying and evaluating views and behaviours across travel mode user groups**

*“No because they use the car without thinking, it’s what they do. . . I don’t even think, think about walking it’s, it’s part of what I do now”*

- **Emma, Walker (105-108)**

### **4.1 Abstract**

*The qualitative work in the previous chapter highlighted a range of interesting results and findings, but given the limited sample, a more representative investigation was warranted. Noting several interesting results from the focus groups, there appeared to be a lack of straightforward comparisons between travel user groups on these aspects. As part of the exploratory work, this chapter highlights results from a large survey comparing users of four main travel mode groups (car, bicycle, bus, and walk) on a range of high-level measures. Results found that active mode users (bicyclists and walkers) showed higher habit strength than other modes, a result that may link to affective appraisals. Replicating previous work (Gatersleben, 2007), the core affect model (Russell, 2003) was applied to discriminate between mode user groups, identifying three significant functions of general positivity, activation, and relaxation. Active travel modes showed extremely positive views of their commute, separated by high arousal for bicyclists and high relaxation for walkers, while car users indicated no substantial affective appraisals. There was a surprising lack of differences in environmental worldviews between travel mode groups, which challenges results from Chapter 3, and may question the validity of explicit measures.*

### **4.2 Introduction**

The qualitative analysis described in the previous chapter highlighted a number of interesting differences and similarities between users of travel mode groups. From clashes on environmental protection, to disparity in reported satisfaction with commute, or the debate over which travel mode was more routine, each group had unique characteristics. The focus-group analysis is the first to apply a qualitative approach to exploring differences between a range of groups travelling to the same location; by combining several different modes, new research ideas can be formulated, and a more detailed understanding of topics can be achieved.

Of course a disadvantage of qualitative work is generalisability: with a very select group of participants, applying results from qualitative work is not possible. Recognised for the ability to examine a topic in great depth, qualitative approaches do not allow us to infer

assumptions about the wider population of those sampled (Barbour, 2007; Willig, 2008). Perhaps not all bicyclists feel so strongly about the environment, or perhaps all car users do not have the same reported satisfaction with their travel modes. However, using a mixed-methods approach the results of the qualitative work can be used to guide the application of quantitative methods: a popular approach in research (Barbour, 2007; Bloor, Frankland, Thomas, & Robson, 2001). With the qualitative work presenting the initial investigation to raise awareness of some research topics, the quantitative method offers a Triangulation approach (Lieber & Weisner, 2010) that illuminates alternative views of the topics that the qualitative approach may miss. Combining two contrasting approaches can give additional complexity to a research question (Teddle & Tashakkori, 2010): a desirable trait when attempting to create several research inquiries. Therefore, a qualitative approach to exploring differences among travel mode groups, using results from the qualitative work is justified.

Much like the qualitative literature however, there appears to be very little quantitative work that directly compares users of several different modes, and again what exists has a strong focus on car use (e.g., Bamberg, Ajzen, & Schmidt, 2003; Gardner & Abraham, 2008). Analyses of non-rational model factors also predominantly focus on car use (e.g., Steg, 2005; Steg, Vlek, & Slotegraaf, 2001; Verplanken, Walker, Davis, & Jurasek, 2008). This is understandable, since car-use is the key target behaviour to reduce for the sake of the environment, health, and the economy. But even with this focus on car users, comparative investigations between user groups may offer additional insights into predicting travel mode choice. If the aim of research is to encourage a change from car to alternative modes, understanding the characteristics of a travel mode could help encourage this change.

This chapter thus focuses on the investigation of differences between groups using a quantitative survey approach, informed by findings from the qualitative research discussed in Chapter 3. Full analysis of the focus-group transcripts used a Grounded Theory approach (Glaser, 1992; Glaser & Strauss, 1967): a process that took some time and consideration to fully develop. With the requirement to complete a university-wide Travel Survey during the first two months of my PhD, focus-group results were first considered for their initial results to guide the formation of the Travel Survey. Though this prevented using the key finding of autonomy to be fully included within the Travel Survey, the range of views led to a number of theoretically interesting questions that could be approached quantitatively.

Firstly, a clear result from the qualitative work was the role of satisfaction and affective experiences within travel mode use: car users enjoyed the time alone, motorcyclists loved the thrill, bicyclists praised exercise and speed, and walkers liked the relaxation. In isolation were the bus users, with strongly negative views on commute experience for a range of reasons (e.g., other people, time, and cost). The role of affective experiences of a behaviour

is important; enjoyment is likely to encourage a person to continue to carry out a behaviour (Steg, 2005), and travelling by car purely for the sake of enjoyment is a recognised phenomenon (Mokhtarian, Salomon, & Redmond, 2001). Affective appraisals of commutes are especially interesting, since the role of satisfaction can be easily overlooked when discussing travel behaviour. Steg, Vlek, and Slotegraaf (2001) found that using less-explicit measures of exploring motives for car use indicated an increased importance of affective experiences (e.g. thrills and satisfaction), which became reportedly less important as questions became more explicit. Subtle influences of affective experiences with car use are also found to be much stronger among regular car users than occasional drivers (Steg, 2005).

Yet as with the previous results, and at the time of the survey (April 2011), there had been limited investigations comparing different travel mode user groups for their affective experiences. The importance of affective appraisals for car use has been shown by Steg and colleagues (Steg, 2005; Steg et al., 2001), but comparisons extending beyond car use were limited (Páez & Whalen, 2010). Some qualitative reports highlighted dissatisfaction with bus use but then also praised the social aspects (Beirao & Cabral, 2007), while walking was praised for relaxation (Darker, Larkin, & French, 2007). Other studies have done some quantitative comparisons between travel mode groups: Anable and Gatersleben (2005) and Páez and Whalen (2010) both compared users of car, bus, walking and bicycling, and their results suggested that affective appraisals were higher for active travel mode users, and lowest for bus users, with car use in the middle. These previous quantitative studies were very exploratory however, using general items relating to various affective components without systematic investigation or backed by theory. This was until Gatersleben and Uzzell (2007) reported affective evaluations of travel by using discriminant function analysis based upon the well-validated Core Affect Grid: a two dimensional grid indicating experiences on a hedonistic pleasure-displeasure scale, and a excitement-based scale of activation-deactivation (Russell, 2003). Using several items to represent the key characteristics of Russell's (2003) model, Gatersleben and Uzzell (2007) clearly highlighted the multi-faceted aspects of affective experiences, such as the 'depressing' yet not 'relaxing' experience of bus use. The work by Gatersleben and Uzzell (2007), however, has not been replicated since their publication, and with a potentially large sample, and the question of affective experiences raised by the qualitative work, I sought to replicate their multi-factor method within the current survey.

Secondly, focus groups raised the issue of how automatic the use of each travel mode was perceived to be. As shown in the opening quote to this chapter, there was uncertainty over which modes were more automatically performed. Behaviour that is automatic and routine can easily be understood as habitual: learned, context-dependent and automatic



behaviours that require very little thought to carry out (Verplanken & Aarts, 1999), and travel mode choice is often viewed as habitual (Wood & Neal, 2007). Theoretical work defining habit has expanded the definition of habitual behaviours toward actions that express an interaction between goals and intentions that are contextually-cued (Wood & Neal, 2007). This interplay between intentions and habits is of particular importance for travel mode choice, since a strong habit renders the influence of intentions ineffective when predicting behaviour (Gardner & Abraham, 2008). Interventions to change behaviour are also challenged by habitual processes, since stronger travel habits are linked to reduced information searches and ability to absorb new information (Aarts, Verplanken, & van Knippenberg, 1997; Verplanken, Aarts, & Van Knippenberg, 1997). In fact, even if information were retained, habit strength influences how people act on their views, and only when habit is weakened after a change in context can the influence of environmental views be observed (Verplanken et al., 2008). The influence of habit also extends to future consideration of other modes; car users with strong habits have significantly lower expectations of satisfaction with other modes (Pedersen, Kristensson, & Friman, 2012), and car users are more likely to remember the experience of using other modes as dissatisfying, even when their experience at the time was rated positively (Pedersen, Friman, & Kristensson, 2011).

Even with the recognition of habitual influences over travel mode choice, and the range of habit strength measures available (Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994; Verplanken & Orbell, 2003; Wood, Quinn, & Kashy, 2002), there are no published comparisons of habit strength between groups. The most comparable research is a minor detail in work by Gatersleben and Uzzell (2007), who asked users of different modes to report the level of cognitive effort required to use a travel mode. Gatersleben and Uzzell (2007) found that bus users reported the highest cognitive effort, with a non-significant trend for active travel mode users (bicycle and walking) to show lower cognitive effort – which may translate into a greater habitual strength. However, since habit is an automatic concept (Verplanken, 2006), and that consciously considering a travel mode choice can reduce habit strength (Eriksson, Garvill, & Nordlund, 2008), there is a possibility that active mode users will have lower habit strength as they require consideration of situational factors (e.g., weather, appropriate clothing, and weight of carried items) that perhaps car users would not consider as much. Observing difference in habit strength, and the automaticity of using a travel mode, could provide new insights not only into the use of a travel mode, but also the formation of habits themselves.

One of the curious results from the qualitative analysis was the contrast in how environmental protection was viewed: despite almost universal acknowledgement of the seriousness of carbon emissions. In the focus groups two distinct views emerged: car and

motorcycle users were cautious about forced change and critiqued any efforts to reduce emissions, while bicyclists and walkers encouraged and saluted efforts to reduce emissions, and expected more action from management. The conflict over how action should be taken, whilst showing apparent agreement toward the main issue, raised the question of how travel mode user groups may differ in their assessment of climate change and environmental worldviews.

To date, there has been little-to-no research that directly compares different travel mode user groups on their environmental worldviews or attitudes (Flamm, 2009). Some UK-wide survey reports have briefly explored the topic: The British Social Attitudes survey (NatCen, 2012) suggests stronger environmental concern is linked to less car use; 39% of people who were 'very concerned' about links between transport and climate change used a car "every day or nearly every day" compared with 51-53% frequently using a car who were "fairly" or "not very" concerned. The DfT Climate Change and Travel Choice national survey (DfT, 2011), reported some increased support for climate change currently occurring for public transport users (46% agree), when compared to only car-using participants (39% agree). However these reports have limited detail, and only encompass one broad question of climate change to base their results upon. More detailed examinations have employed more established measures of environmental worldviews, such as the New Environmental Paradigm (NEP: Dunlap, Van Liere, Mertig, & Jones, 2000), the most popular and well-validated measure of environmental views (Dunlap, 2008), but do not offer comparisons between travel mode user groups. Poortinga, Steg, and Vlek (2004) used the NEP to predict energy-saving behaviours, and found no link between stronger environmental worldviews and reduced car use (but was significantly linked to the acceptability of reducing car use). Whitmarsh and O'Neill (2010) found that the NEP was not a significant predictor of eco-driving, nor was using alternative travel modes for short journeys (< 3 miles). The link between environmental worldviews and travel mode choice is uncertain, and open to more influences than just environmental views (Steg & Vlek, 2009). In a meta-analytical review of influences on car use, Gardner and Abraham (2008) did find a significant, albeit very weak, link between concern and reduced car use, though again note the need for more understanding. With an absence of any substantial comparisons between travel mode users on environmental views, and recurring calls for more research, the current survey included a comparative measure of environmental worldviews.

The fourth area of interest relates to how affective appraisals of commute mode were discussed in the previous chapter qualitative work, and the implications these views may have. Active travel users mentioned how using their modes facilitated improved mood, relaxation, and mental health benefits, while car users expressed the satisfaction with

'clearing the head' when driving. One interpretation of these descriptions links to the idea that the affective experience of a travel mode may offer more than satisfaction, but could reflect improvements in a person's mental well-being. In a theoretical proposal, Ettema, Gärling, Olsson, and Friman (2010) suggested that successful use of travel mode, similar to the blending of affect and utility described by Gardner and Abraham (2007), may be linked to increased Subjective Well-Being (SWB): the extent a person generally feels positive about their life (Diener, Emmons, Larsen, & Griffin, 1985). Later research by Jakobsson Bergstad et al. (2011) demonstrated this link between SWB and transport, finding that increased travel satisfaction was linked to SWB, and that car use had a small but positive influence on SWB. Links between transport and SWB are important as several researchers have linked low SWB to general poor mental health, and SWB is correlated with traits such as depression and eating disorders (Keyes & Lopez, 2002). Given the range of affective responses linked to travel mode, and the link between affective experiences and SWB, it raises the question on whether users of different travel modes may differ in their mental well-being. Additionally, the link between physical activity and mental well-being may have an effect. Some systematic reviews and studies have found a positive relationship between physical activity and mental well-being (Penedo & Dahn, 2005; Stathopoulou, Powers, Berry, Smits, & Otto, 2006; Windle, Hughes, Linck, Russell, & Woods, 2010). Active travel modes are recognised for the benefits of increased physical activity compared to sedentary car use (Rabl & de Nazelle, 2012). Given that both the active and sedentary travel mode user groups expressed praise for mental relaxation, the current survey sought to clarify if actual differences in mental well-being existed between travel mode user groups.

Lastly, with some clear differences between user groups in Chapter 3, I also sought to establish if personality traits varied among user groups; would the thrill that motorcyclists sought reflect greater extraversion, and are the walkers' desires for calm related to stronger agreeableness? Unfortunately, as described in the methodology section, the included measure of personality traits (Gosling, Rentfrow, & Swann Jr, 2003) proved unreliable, and are mentioned here only for full disclosure.

In summary, this chapter compliments the qualitative work in the previous chapter, and explores a range of psychologically interesting features between travel mode groups. Using a quantitative survey, the intention is to further define a series of research questions that may be explored in more detail. By using a survey approach without specific topics of investigation, the intention is also that the results could be useful as a general test of comparisons between user groups; where differences or similarities are found, the patterns may be further investigated to uncover potential reasons. With a lack of basic comparative

research between users of travel mode groups, this survey offers an ideal opportunity to investigate new areas of travel mode choice research.

### **4.3 Study 2**

#### **4.3.1 Ethical Approval**

Approval was granted by the University of Bath Faculty of Humanities, Chair's Action.

#### **4.3.2 Method**

The survey was run online to increase accessibility, ease of collecting data, and cost-effectiveness. All students at the university had access to computers through the library, and the majority of staff had internet access. For staff with no computer access, such as groundskeeping staff or porters, a paper copy of the survey was designed with open 'workshops' held for staff to visit and complete the survey if they wished to take part.

The survey was advertised largely through online media, with some additional posters displayed across campus. Variations on the advertisement were created and displayed on the university campus homepage, university student's homepage, television screens in the student union facilities and cafes. Posters advertising the survey were also printed and distributed for display across all university departments, for both internal and public noticeboards, and were displayed in public areas across campus. Advertisements can be found in Appendix B of this thesis. To introduce staff and students to the survey, emails were sent by the Deputy Vice-Chancellor, outlining the purpose and scope of the survey and with a link for participants to follow and complete the online survey. As an incentive, advertisements highlighted the chance for participants to enter and win a prize draw for £150 of travel vouchers.

Because of the unusually late date for the 2011 Easter holidays, and to avoid running the survey in examination period, the survey was run in two phases. A survey for students was launched on the 12th of April, and the staff survey was launched on the 3rd May. The original deadline for the survey was the 13th of May, but was extended by one week and closed on the 20th of May. In total, the survey was open to students for five weeks, and open to staff for three weeks. At 5pm on the 20th of May, the surveys were closed and the prize draw held.

The design of the survey questionnaire accommodated input from various groups on drafts of the survey, with comments considered from the Learning and Teaching Development Officer, representatives from the University and College Union (UCU) and university workers union (UNITE), the Student Union, and student representatives for welfare and diversity. University departments were also consulted, with feedback received from the Department of Estates, the head of security services, the Corporate Communications Office, as well as comments from the Vice-Chancellor's group.

The structure of the survey was split into two sections: a ‘conventional’ travel survey, and optional ‘psychology’ section. The ‘conventional’ survey asked respondents about their demographic information, regular travel mode, potential travel issues, views on travel policies affecting the university, and a section on disability and access. Participants were then offered the chance to take part in the optional ‘psychology’ section. If participants did not wish to take part, they were thanked for their time and offered a chance to enter the prize draw.

Consultations with university groups highlighted a concern for ‘survey fatigue’ - a fear that because several surveys for staff and students ran close to the date of this survey, people would be put off from participating. It was agreed that, to make the survey more user-friendly, almost all questions within the survey would be optional. The exceptions were two key questions: a description of respondent’s daily travel, and whether they consented to the optional psychology section. Respondents were requested to complete as much of the survey as possible.

#### **4.3.3 Measures**

Affective appraisals of the daily commute replicated work by Gatersleben and Uzzell (2007), with participants describing their commute on six affective items: Pleasant, Exciting, Relaxing, Stressful, Depressing, and Boring. Each item was rated on a 7-point Likert scale.

To measure habit, the Self-Report Habit Index (SRHI: Verplanken & Orbell, 2003) was completed by participants considering their main mode of travel to the university. The 12-item set of statements relating to automaticity used a 7-point Likert scale for assessing statements ranging from ‘Strongly Disagree’ to ‘Strongly Agree’. It has been suggested that the SRHI may be biased by including a measure of identity (Gardner, de Bruijn, & Lally, 2011), which could influence results for bicyclists with a strong group identity (Daley & Rissel, 2011; Spinney, 2009). To counter this possible bias, habit scores are calculated from 11 items and exclude the item “That’s typically me”. The SRHI showed good internal reliability within the sample (Cronbach’s  $\alpha = .83$ ).

Environmental worldview was measured using the New Environmental Paradigm (NEP: Dunlap et al., 2000) a 16-item instrument that measures attitudes across five domains relating to the environment; reality of limits to growth, anti-anthropocentrism, fragility of nature’s balance, rejection of exceptionalism, and possibility of an eco-crisis. These five domains can be combined into one overall score of environmental concern, and used a 7-point Likert scale ranging from ‘Strongly Disagree’ to ‘Strongly Agree’. The NEP scale achieved a good internal reliability (Cronbach’s  $\alpha = .83$ ).

Mental well-being was assessed using the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS: Tennant et al., 2007). Including 14 items reflecting positive affect,

satisfying interpersonal relationships and positive functioning, the WEMWBS showed excellent reliability, Cronbach's  $\alpha = .91$ .

Personality was measured using the Ten-Item Personality Index (Gosling et al., 2003) using two items for each of the 'Big Five' personality constructs (Larsen & Buss, 2010). However, reliability for each of the constructs proved troubling, with Cronbach's  $\alpha$  shown for assessment of: Extraversion (.72), Agreeableness (.24), Conscientiousness (.60), Emotional Stability (.68), and Openness to Experience (.43). Given the unreliability of several of these measures, analysis of personality is not reported here.

#### 4.3.4 Participants

By the close of the survey on the 20th of May, there were 2,756 responses logged on the survey. From these responses, 140 cases did not report any information on their travel mode, and were removed from the data set. The 2,616 remaining responses formed the basis of the survey report for the university. This chapter however, focuses upon the optional psychological section. From the 2,616 responses, 1,704 individuals offered to take part: an uptake of 65.1% of all participants.

The 1,704 can be broken down by travel mode choice: 635 (37.3%) reported car use as their main mode, 587 (34.4%) used the bus, 265 (15.6%) walked and 122 (7.2%) used a bicycle, with the remaining 95 (5.5%) using other modes. With a much smaller number of people using 'other' modes (motorcycle, train, or reported "other" as main mode), these were excluded from analysis since inferences about larger populations would prove troublesome, and severe imbalances of sample sizes can influence some statistical tests (Tabachnick & Fidell, 2013). This left four main groups: walkers, bicycle users, bus users, and car users (N = 1609).

As a university-wide survey, staff/student response ratios varied. In general there were 709 (44.1%) staff responses, and 900 (55.9%) student responses. Description of staff and student demographics are shown in Table 2.

**Table 2: Staff, student, and combined sample demographics**

Group	Age		Female	
	Mean	SD	n	%
Staff	43.9	10.8	394	55.6
Student	22.3	4.9	501	55.7
Total	31.7	13.4	895	55.6

The proportion of staff using each mode were; 44.3% of bicyclists, 12.3% of bus users, 81.7% of car users, and 24.2% of walkers. Mean age and gender ratios are shown for car users (M = 41.1, SD = 12.7, 59% female), bus users (M = 23.9, SD = 7.7, 59.6% female), walkers (M = 26.7, SD = 11.0, 53.4% female) and bicyclists (M = 31.6, SD = 13.0, 26% female). With

different proportions of staff/student for each travel mode, this may confound comparisons between groups (e.g., income, age, etc.), so where possible, staff/student status is controlled for in the analyses.

Using a university-wide survey, with the opportunity to withdraw from the psychology section, response bias was tested by comparing proportions of each travel mode willing to complete the psychology section. Proportions of each mode agreeing to additional psychology questions for bicyclists (77.7%), bus users (72.3%), car users (72.6%) and walkers (67.3%) compared using a chi-square test were found to be not significantly different,  $\chi^2(3) = 6.883, p = .076$ .

#### **4.3.5 Missing Data**

In an appeal to attract a large number of respondents, the survey did not require participants to complete all questions; this led to a number of participants who did not complete all psychological scales or complete all of the items on a particular scale. The problem of how to deal with missing data is complex, and influenced by whether missing data have a particular pattern, and what methods are used to address the problem (e.g. imputation or removal). The first step is to determine whether missing data are correlated with measured variables within the data; that is, whether there are harmless reasons for missing data, or if the missing data plausibly reflects bias (Howell, 2007). There are three classifications for how data can be missing:

1. Missing Completely at Random (MCAR)

Data that are missing due to influences completely unrelated to the factors within the data. MCAR data may occur when variables outside of measurement or expectation influence the data: examples include equipment malfunction, sickness of participants, or errors in data entry. MCAR is the most favourable circumstance, since corrections will not lead to biased parameter estimates, but may reduce the power of the analysis in small samples (Howell, 2007).

2. Missing at random (MAR)

A slightly different problem from MCAR data, but a more common factor in data sets (Harel, Zimmerman, & Dekhtyar, 2008). MAR data may not be related to the response on the variable, but related to other observed factors. An example would be the reporting of household income dependent on marital status: if we imagine unmarried couples are less likely to report their income than married couples, and assume unmarried couples have lower incomes, the data would be MAR if the likelihood of missing data is related to marital status, but not to income (Allison, 2001).

### 3. Missing not at random (MNAR)

When the above two assumptions are not met, missing data may be classified as MNAR. An example would be if people who drink alcohol more than average may not answer a question on their alcohol intake: the variable measured is related to the likelihood of missing data (Harel et al., 2008). Understanding the patterns behind MNAR data is more difficult, as it suggests a model the researcher has not accounted for (Howell, 2007), and there are no established means of differentiating between MAR and MNAR data (Harel et al., 2008).

To determine the nature of the missing data, Little's MCAR Test was run for each of the five scales in question. Quantitative results for all five scales (composed of 53 items) were included in Little's MCAR test with additional categorical data for main travel mode included to account for possible MAR data: results were non-significant, indicating that the missing data could be classified as MCAR  $\chi^2(9398) = 9564.638, p = .113$ ). As missing data were not reflective of the measures in the survey (and likely unbiased), a straightforward analysis of the data using complete cases is an acceptable method (Hardy & Bryman, 2004; Schafer, 1997), and was used for this analysis

## 4.4 Results

It should be noted that with such a large sample size, analysis places greater emphasis on effect sizes, such as Hedge's  $g$  and partial eta squared  $\eta^2$ , than significance testing. With a large sample, even trivial correlations or differences can be interpreted as statistically significant (Walker, 2010), and effect sizes are employed to illustrate the relative strength of results. Of note, Hedge's  $g$  is selected over the more commonplace Cohen's  $d$  for two reasons. Hedge's  $g$  corrects for bias when calculating pooled sample standard deviation when sample sizes are unequal (a feature of the current dataset), and also allows a useful 95% confidence interval to be calculated around the effect size (Durlak, 2009). When interpreting results, general guidelines (though by no means exact) for Hedge's  $g$  are 'small' (0.2), 'medium' (0.5) and 'large' (0.8) as advised by Durlak (2009), and partial  $\eta^2$  values as small (.009), 'medium' (.059) and 'large' (.138) as described by Richardson (2011).

### 4.4.1 Affective Appraisals

Affective appraisal of commute, based on Gatersleben and Uzzell (2007), used six measures assessing the extent to which commuting was seen as Exciting, Pleasant, Relaxing, Depressing, Boring, and Stressful. Discriminant function analysis was used to establish how the travel mode groups might be classified by their traits on these six variables. Discriminant analysis can be viewed as a combined MANOVA and multiple regression approach,



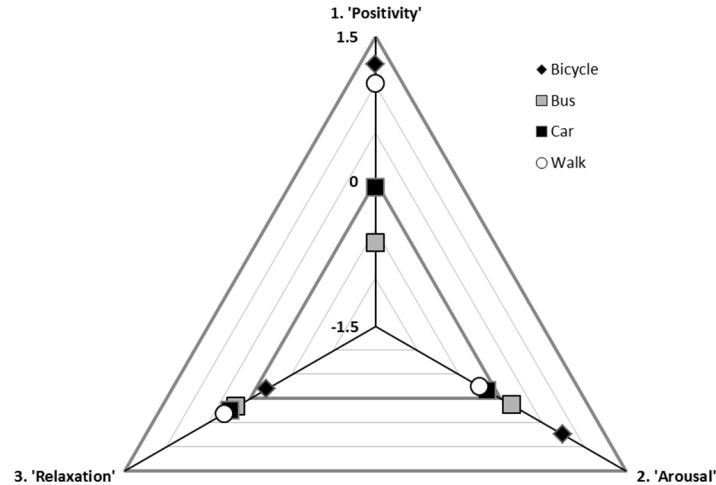
evaluating differences between groups (similar to MANOVA) on linear combinations of variables. Combinations of variables (weighted by predictive ability) are calculated into canonical variables, or functions, that best discriminate between the established groups. There will always be one function fewer than the number of outcome groups, but it is possible that not all the functions are useful for predicting which group a person will fall into. Discriminant function analysis revealed all 3 functions significantly contributed to group separation. The structure matrix loadings of each of the 6 affective appraisals onto these functions, and the standardised canonical discriminant function coefficients used to calculate discriminant scores shown in Table 3.

**Table 3: Structure Matrix Loadings & Standardised Canonical Function Coefficients. Note: Only functions loadings >.40 displayed, as advised by Field (2009).**

Item	Structure Matrix			Standardised Canonical Function Coefficients		
	Positivity	Arousal	Relaxation	Positivity	Arousal	Relaxation
Pleasant	-.732			0.179	0.044	1.040
Exciting	-.627	.714		-0.436	0.930	0.205
Relaxing	-.548		.609	0.179	0.044	1.040
Boring	.717		.412	0.280	0.103	0.768
Depressing	.578			0.032	-0.387	0.118
Stressful	.752	.496		0.550	0.503	-0.265

The first function explained 78.1% of the variance (canonical  $R^2 = .30$ ), the second explained 12.5% of the variance (canonical  $R^2 = .07$ ), and the third explained 9.4% of the variance (canonical  $R^2 = .05$ ). Combination of the three functions significantly differentiated travel mode users,  $\Lambda = 0.62$ ,  $\chi^2(18) = 696.1$ ,  $p < .001$ . Removing the first function maintained a significant discrimination between groups using Functions 2 and 3,  $\Lambda = 0.89$ ,  $\chi^2(10) = 171.5$ ,  $p < .001$ , and the third function in isolation significantly discriminated between group users,  $\Lambda = 0.95$ ,  $\chi^2(4) = 73.7$ ,  $p < .001$ .

Function 1, which discriminates groups based on low scores on the three positive measures (pleasant, exciting, and relaxing) and high scores on the three negative measures (depressing, boring and stressful), was reversed for ease of interpretation and named “Positivity”. Function 2 discriminated groups based on high scores for the ‘exciting’ and ‘stressful’ measures, and was named “Arousal”. Function 3 was named “Relaxation” and discriminated groups based on high ‘relaxing’ and ‘boring’ variables. With three significant functions, displaying group centroids on each of the significant functions requires a three-dimensional plot, shown in Figure 6 below.



**Figure 6: Radar plot mapping travel mode group affective appraisal centroids on the three identified discriminant functions. Positive scores on the function appear closer to the edge, and negative scores appear closer to the middle.**

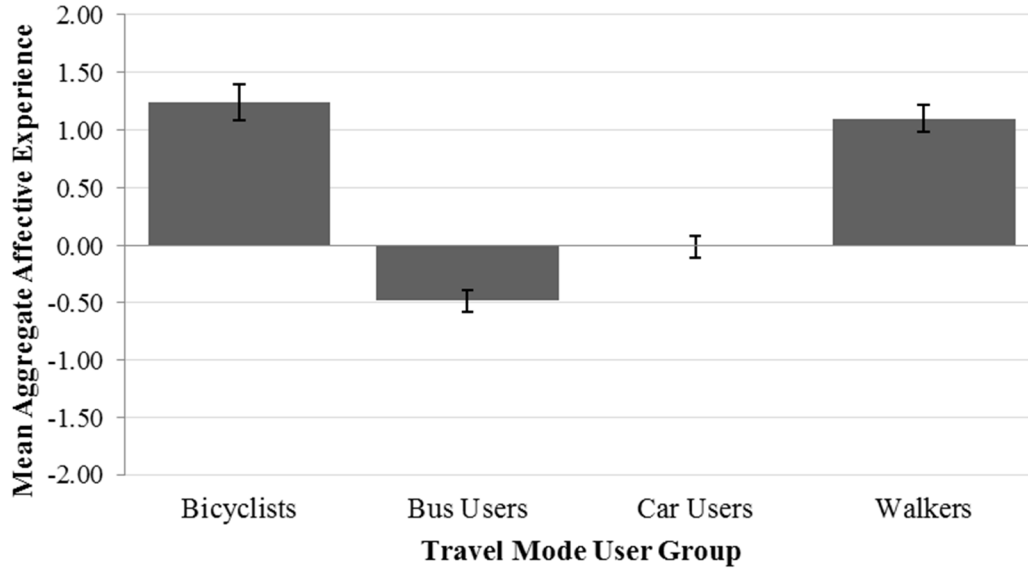
The group centroids are also shown in Table 4 below.

**Table 4: Group centroids of identified discriminant functions for each user group.**

Group	Function		
	Positivity	Arousal	Relaxation
Bicycle	1.212	0.74	-0.198
Car	-0.065	-0.164	-0.244
Bus	-0.637	0.133	0.166
Walk	1.018	-0.251	0.306

Table 4 shows bicycling to be strongly associated with higher positivity, higher arousal and low relaxation. Walkers display similarly strong levels of positivity, with lower levels of arousal and high relaxation. Bus use is defined by low positivity and moderate arousal (though also relaxing), while car use sits close to zero on positivity and arousal, and has a moderately negative link to relaxation. Interestingly, this suggests car commuting was not associated with any particularly strong affective experiences.

As mentioned above, the first function ('Positivity') found all 6 affective measures to be strong discriminant predictors of travel mode group. It was also, as indicated by the canonical  $R^2$  scores, by far the most important discriminator amongst travel mode groups. To explore this factor more clearly, the 6 variables were collated into a single scale of affective experience. Anchored around 0 ( $\pm 3$ , given the original 7-point scales that included a neutral point), and with negative items reversed (depressing, boring, stressful) the scale proved to have good reliability ( $\alpha = .88$ ). Aggregate scores are shown for car users ( $M = -0.01$ ,  $SD = 1.14$ ), bicyclists ( $M = 1.24$ ,  $SD = 0.87$ ), bus users ( $M = -0.49$ ,  $SD = 1.14$ ) and walkers ( $M = 1.10$ ,  $SD = 0.84$ ). Comparison of travel modes using this aggregate affective experience scale is shown in Figure 7.



**Figure 7: Mean aggregate affective commute experience for each of the main modes, 95% CI shown.**

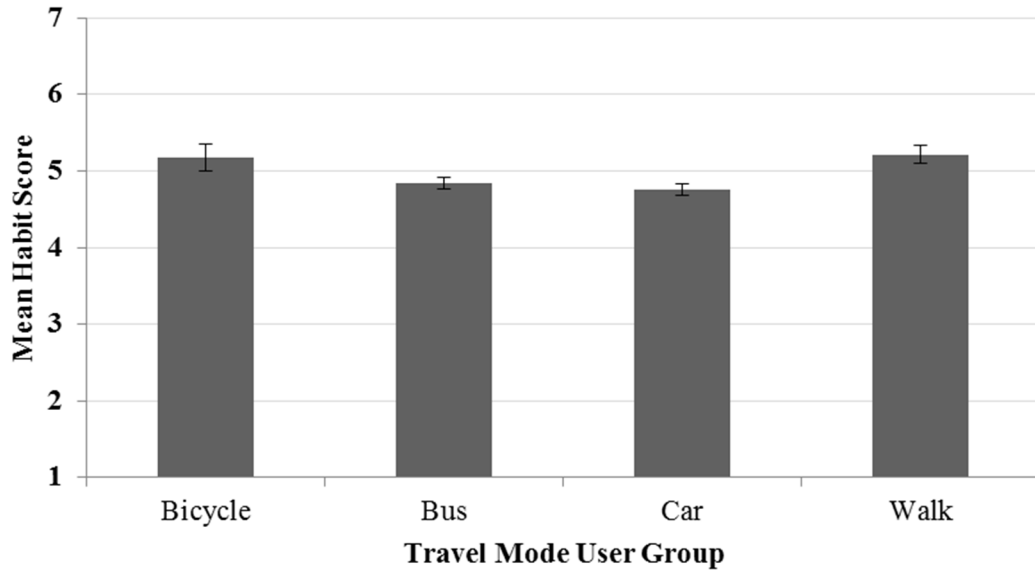
Two-way ANOVA indicated a significant but very small effect of staff/student status,  $F(1, 1348) = 5.197, p = .023, \eta_p^2 = .004$ . A significant and large effect of travel mode group, controlling for staff/student status was also found,  $F(3, 1348) = 104.256, p < .001, \eta_p^2 = .188$ .

With unequal sample size groups, both Gabriel's and Hochberg's GT2 post-hoc tests were used since Gabriel's is recognised as more powerful but influenced by heavily uneven samples (Field, 2009). Gabriel's and Hochberg's GT2 post-hoc analysis indicated bus affective appraisal was lower than bicycle, walking or car (all  $p < .001$ ;  $g = 1.57$  [95%: 1.49 to 1.65],  $g = 1.50$  [95%: 1.43 to 1.58],  $g = 0.42$  [95%: 0.36 to 0.49] respectively). Car affective experience was lower than bicycle or walking ( $p < .001$ ,  $g = 1.13$  [95%: 1.06 to 1.21] and  $g = 1.05$  [95%: 0.98 to 1.12] respectively). There was no significant difference between bicyclist and walker affective experience (Gabriel's  $p = .836$ , Hochberg's GT2  $p = .845$ ,  $g = 0.16$  [95%: -0.25 to -0.08]). A one-sample  $t$ -test for car users showed no significant difference from zero,  $t(524) = -.108, p = .914$ , again indicating the lack of any strong affective experience in this group.

There was also a small significant interaction effect between staff/student status and travel mode group,  $F(3, 1348) = 3.809, p = .01, \eta_p^2 = .008$ . The interaction arose because whilst affective experience with cycling was similar in staff ( $M = 1.19, SD = 0.88$ ) and students ( $M = 1.28, SD = 0.86$ ), and whilst affective evaluations with the car was similar in staff ( $M = -.01, SD = 1.16$ ) and students ( $M = .03, SD = 1.02$ ), affective experience with buses from staff ( $M = -.23, SD = 1.13$ ) and students ( $M = -.52, SD = 1.14$ ) was significantly different ( $g = .25$  [95%: 0.20 to 0.31]), as was affective experiences with walking: staff ( $M = 1.54, SD = 0.88$ ), students ( $M = 0.96, SD = 0.78$ ),  $g = 0.70$  (95%: 0.66 to 0.74).

#### 4.4.2 Travel mode habit

Mean habit strength scores using the SRHI (Verplanken & Orbell, 2003) using a 1 (low habit strength) to 7 (high habit strength) are reported, with mean habit scores displayed in Figure 8.



**Figure 8: Mean habit strength scores for each main mode (without identity item), 95% CI shown.**

Two-way ANOVA indicated a significant, but small effect of staff/student status,  $F(1, 1389) = 10.448$ ,  $p < .001$ ,  $\eta_p^2 = .009$ , caused by students ( $M = 5.00$ ,  $SD = .92$ ) having slightly stronger travel habits than staff ( $M = 4.77$ ,  $SD = .92$ ). Independent of this, there was a significant small-to-moderate effect of travel mode group on habit strength,  $F(3, 1389) = 8.81$ ,  $p < .001$ ,  $\eta_p^2 = .023$ .

Gabriel's and Hochberg's GT2 post-hoc analysis between modes indicated bicyclists showed greater habit strength than bus users ( $g = 0.39$ , 95%: 0.32 to 0.45) and car users ( $g = 0.54$ , 95%: 0.48 to 0.61), both with  $p < .001$ . In addition, walkers had stronger habits than bus users ( $g = 0.43$ , 95%: 0.37 to 0.49) and car users ( $g = 0.59$ , 95%: 0.52 to 0.65), both with  $p < .001$ . There was no significant difference in habit between bicyclists and walkers (Gabriel's and Hochberg's GT2  $p = .99$ ,  $g = 0.04$ , 95%: -0.05 to 0.14), nor between bus and car users (Gabriel's and Hochberg's GT2  $p = .668$ ,  $g = 0.19$ , 95%: 0.17 to 0.24). Walkers and bicyclists together show stronger habits, and car drivers and bus users show weaker habits. No significant interaction between staff/student status and mode group was found,  $F(3, 1389) = .329$ ,  $p = .804$ .

#### 4.4.3 Environmental Worldviews

Environmental worldviews, as measured by the NEP (Dunlap et al., 2000), by travel mode. Mean values of NEP scores, between 1 (low NEP worldview) and 7 (high NEP worldview)

were calculated for car users ( $M = 4.85$ ,  $SD = 0.81$ ), bicyclists ( $M = 5.00$ ,  $SD = 0.75$ ), bus users ( $M = 4.82$ ,  $SD = 0.74$ ), and walkers ( $M = 4.85$ ,  $SD = 0.81$ ).

Two-way ANOVA of mean NEP scores indicated a small significant effect of staff/student status,  $F(1, 1358) = 18.329$ ,  $p < .001$ ,  $\eta_p^2 = .013$ , with staff environmental worldviews ( $M = 4.94$ ,  $SD = .82$ ) greater than students ( $M = 4.7$ ,  $SD = 0.74$ ,  $g = 0.21$  (95% CI: 0.17 to 0.25)). A significant but very small separate effect of travel mode was found,  $F(3, 1358) = 3.211$ ,  $p = .022$ ,  $\eta_p^2 = .007$ , and there was no significant interaction,  $F(3, 1358) = 1.79$ ,  $p = .147$ . Both Gabriel's and Hochberg's GT2 post-hoc tests indicated no significant comparisons between travel mode groups.

#### **4.4.4 Mental Well-Being**

Mental well-being assessed using the WEMWBS (Tennant et al., 2007) ranges from a possible 14 (low mental well-being) to 72 (high mental well-being), and scores are reported for car users ( $M = 52.07$ ,  $SD = 8.14$ ), bicyclists ( $M = 51.72$ ,  $SD = 7.32$ ), bus users ( $M = 50.42$ ,  $SD = 8.97$ ) and walkers ( $M = 50.69$ ,  $SD = 8.27$ ). A two-way ANOVA found no significant effect of staff/student status,  $F(1, 1362) = 2.514$ ,  $p = .113$ , no significant effect of travel mode group,  $F(3, 1362) = .439$ ,  $p = .725$ , and no significant interaction,  $F(3, 1362) = .739$ ,  $p = .529$ .

### **4.5 Discussion**

This chapter describes an exploratory survey of staff and students that evaluated several interesting topics highlighted in the previous qualitative exploration. Using data from 1,609 respondents, the survey compared users of four main travel mode choices: Car, Bus, Walk, and Bicycle. Taking inspiration from the exploratory qualitative work in Chapter 3, the survey covered five topics: affective appraisals of the daily commute, strength of habit, environmental worldviews, mental well-being, and personality traits.

#### **4.5.1 Comparing Affective Appraisals of Daily Commute**

A replication of Gatersleben and Uzzell (2007), the survey asked respondents to rate their commute on six affective items based upon the Core Affect framework by Russell (2003). Discriminant function analysis indicated three factors: a measure of general positivity, one of excitement and arousal, and a third for relaxation yet boredom. In their original work, Gatersleben and Uzzell (2007) found two factors of "relaxing-stressful" and "depressing-exciting". Though comparable with the previous results when separating active modes from car or bus use, I argue that the functions identified here are more appropriate for two reasons. Firstly, Russell's (2003) Core Affect grid places evaluations on two axes representing pleasure/displeasure, and arousal/relaxation. Gatersleben and Uzzell (2007) found two functions, but both seemingly focused on Russell's (2003) arousal/relaxation axis without a

clear link to the role of pleasure/displeasure. The current results, in contrast, show a clearly defined positive/negative function, with two additional functions that identify arousal/relaxation, fitting more closely to Russell's original framework. The second reason is the application of these functions; Gatersleben and Uzzell (2007) found that bicycling was contradictorily represented by both high 'excitement' and 'relaxation' scores, while the current results defined bicycling as positive and exciting, whilst low on relaxation. This also appears more fitting to the qualitative results in Chapter 3, with positive comments from both bicyclists and walkers, relating to excitement and relaxation separately: a finding the current analysis supports. Although the arousal/relaxation function was split into separate functions, results are more comparable to the original affect framework (Russell, 2003), and travel mode groups appear to be more accurately defined.

Analysis also suggested that the six affective items could be collapsed into a single measure to compare travel mode user groups, and clearly showed active mode users' strong positive experiences, with negative appraisals from bus users: results that also support the qualitative findings in Chapter 3. Other investigations also suggest that active mode users have the strongest positive evaluation of their commutes, with bus users generally the lowest (Anable & Gatersleben, 2005; Olsson, Gärling, Ettema, Friman, & Fujii, 2012; Páez & Whalen, 2010). The current results add to these discussions by illuminating the different aspects linked to satisfaction: walking and bicycling are equally positive, but where cycling is exciting, walking is relaxing. Yet interestingly, the general affective experience for car users was not significantly different from neutral. This stands in contrast to a number of views associating car use with satisfaction or the affective experience: results in Chapter 3 clearly demonstrated people's enjoyment and passion for driving, affective responses predict greater commuting car use (Steg, 2005), the positive rating of car use affective experiences (Anable & Gatersleben, 2005), and even the importance of affect-based appeals when advertising cars (Bayley, Emerson, & Wright, 2009).

As a speculative observation, the neutral responses of car users may reflect the 'default' status of car use without strong affective responses. The car is the most popular travel mode in the UK (DfT, 2013), and other travel modes are compared against the 'norm' of car use (Chapter 3). As a default choice, car use may occur with limited consideration and affective response, while alternative modes (e.g. active modes) may be specifically chosen, or people may be forced to use a mode when unable to drive (e.g. bus use). Positive affective responses predict increased car use (Steg, 2005), and people may desire affective responses to car use (Steg et al., 2001), but perhaps for most people, affective experience of car use commuting is limited (Anable & Gatersleben, 2005). The idea of normative behaviour with limited affective appeal (for the majority) presents the possibility that people's defence of car

use as enjoyable may be due to cues provided by surveys or interviewers (Hafner, Walker, Verplanken & Skippon, in prep), and given that car users' remembered satisfaction with public transport may be biased (Pedersen et al., 2011; Pedersen et al., 2012), remembered satisfaction of car use itself may also be influenced.

Combining the six affective evaluations into a single measure raised the idea that a new, specific measure for affective appraisal of travel could be developed through this research. However, the survey was launched in April 2011, and in May 2011, the Satisfaction with Travel Scale (STS: Ettema et al., 2011) was published. Similarly based upon the Core Affect grid (Russell, 2003), with additional components of cognitive evaluation of travel mode, the STS offers a multi-aspect measure that can be collapsed into a single score (Ettema et al., 2011). Since its publication, psychometric evaluations of the STS show promising results (Friman, Fujii, Ettema, Gärling, & Olsson, 2013), and like this study, found that positive evaluations of travel mode choice are highest for active modes, then car users, and lowest for bus/public transport users (Olsson et al., 2012). The current results aimed to replicate the discriminant function analysis work by Gatersleben and Uzzell (2007), with results largely compare to theirs, though the current functions identified more closely match the Core Affect model (Russell, 2003). The STS offers an exciting approach to the measurement of travel mode satisfaction, and would appear to be the most applicable scale for future use. It would be illuminating for future work to evaluate travel mode groups using discriminant analysis through the STS, and further evaluate affective characteristics of travel mode choices.

#### **4.5.2 Habit strength stronger in active travel mode users**

When comparing habit strength, active mode users (bicyclists and walkers) held stronger habits than car and bus users, with effect sizes suggesting moderately large differences. To the best of my knowledge, this study is the first direct comparison of habit strength between users of different travel modes. Some previous work has suggested that active travel mode users report lower levels of cognitive effort than other modes (Gatersleben & Uzzell, 2007), which may reflect greater automaticity through habit (Verplanken, 2006), though this trend was non-significant and offers no detail into why habit strength may be lower. An initial hypothesis proposed earlier mentioned that unlike for car users, weather and weight constraints may require increased consideration, and reduce active modes' habit strength, though this seems to be unlikely given the results. Using a sample of respondents travelling to the same location provides a useful benchmark, since respondents have the same end-state objective (arriving at the university) but differ in their modal choice, which may help control for complexities of goal-intention motives in habit strength (Wood & Neal, 2007). The measure of habit used (Verplanken & Orbell, 2003) also excluded any mention of identity, which has been

suggested to bias some habit strength reports (Gardner et al., 2011). Given the strong identity associated with bicycling (Daley & Rissel, 2011; Spinney, 2009), excluding identity from the habit measure removed any possible influence. Also, since the analysis controlled for staff/student status, demographic influences, or possibly increased habit strength from a longer history of commuting to the university, would also likely be removed.

One potential explanation for the increased habit strength of active mode users may lie in the role of affective experience. In their theoretical discussion of habits, Wood and Neal (2007) define habit using three propositions: 1) habits are context-cued to environments or affective responses; 2) habits are goal-independent and can influence action or thought without the requirement of a goal; 3) habits interact with goals and intentions so that they may each influence behaviour. Discussing their first proposition, Wood and Neal (2007) suggest that habits may either be cued as a *direct* form where the habit is instigated by “cold” (p.844) and direct links to context (akin to behaviourist principles), or cued as a *motivated* form that additionally builds upon positive affective experience, as well as context. With stronger and more positive affective evaluations reported by active mode users, and increased habit strength, their positive evaluations may encourage the formation of motivated habits that increase the automaticity of the behaviour. With positive affective experiences that arguably add additional rewards of enjoyment to a behaviour, habit strength may increase in line with Wood and Neal’s (2007) view: “*it is possible that motivational cuing works to augment and enhance, rather than replace, context–response learning based on direct cuing*” (p.846).

Links between habit and emotion are uncertain; previous work suggests that habits are dissociated from emotions, given that the automaticity and repeated nature removes them from consciously processing emotions (Wood et al., 2002). The current argument however avoids discussion of emotions, but refers to the affective experiences of travel mode use. In line with other researchers, affective experiences can be understood as automatic positive or negative ratings, rather than the conscious and considered aspect of emotion (Aarts, Custers, & Veltkamp, 2008; Slovic, Finucane, Peters, & MacGregor, 2007). With links between positive affect and increased goal motivation (Aarts et al., 2008; Custers & Aarts, 2005), and since habitual processes may develop from repeated goal motivation (Wood & Neal, 2007), increased positive affect from a repeated behaviour may lead to stronger habit strength. An analysis of enjoyment and behaviour maintenance has similarly suggested that positive affective feedback can reduce the cognitive need to evaluate options and may encourage habit formation (Phillips & Chapman, 2012). Comparing habit strength for people who complete the same task (e.g. regularly travelling to the same location), those who gain more positive affective experiences may develop stronger habits. This hypothesis requires more consideration and testing in the future, but has potentially large implications for habit theory



and the promotion of alternative travel modes. If alternative travel modes can emphasise the initial enjoyment of a first few experiences, perhaps a habit may be more easily formed.

#### **4.5.3 Environmental Worldviews are comparable across travel mode groups**

General environmental worldviews for each travel mode group were compared using the New Ecological Paradigm (NEP: Dunlap et al., 2000). Results first indicated a significant, albeit extremely small, difference in NEP scores across travel mode groups. Post-hoc statistical tests were unable to define these differences however: an additional indication that any differences were minuscule (Cardinal & Aitken, 2013). Given the large sample size with good statistical power to detect small differences (Tabachnick & Fidell, 2013), there appears to be no recognisable differences in environmental worldviews between travel mode user groups. Previous studies applying the NEP to travel mode choice have generally explored car use, with results also questioning the link between environmental worldviews and travel mode choice. Poortinga et al. (2004) regressed NEP scores against car use and transport behaviour but found no significant link, and Whitmarsh and O'Neill (2010) likewise found that the NEP was a non-significant predictor of reduced car or flight use. Alternatively, in a meta-analysis of psychological correlates of car use, Gardner and Abraham (2008) identified small and weakly negative links between reduced car use between measures of general environmental awareness, and for measures of responsibility for environmental consequences. In contrast, the current study offers the first comparative analysis of environmental worldviews across several different travel mode choices, and found no substantial differences. This result is somewhat surprising, especially given the popular stereotypes of bicyclists as 'greener' people (Daley & Rissel, 2011; Gatersleben & Haddad, 2010), or using environmental identity to define "car-less crusaders" when segmenting travel mode users (Anable, 2005, p. 74).

Comparing the current survey results to the qualitative discussions in the previous chapter, clear differences in views of environmental action were found. In the Chapter 3 focus groups, active mode users favoured policy changes and called for more action, while car users dismissed managerial changes and carbon reduction targets. Importantly, however, focus group participants gave explicit support to general environmental issues. It may be possible that the NEP (Dunlap et al., 2000) as a general measure of environmental worldviews, was not able to detect specific differences. Using questions that directly link car use to environmental impacts has found a significant relationship to reduced car use, and increased use of alternative modes (Steg & Sievers, 2000). By using different approaches to general environmental worldviews, such as measuring environmental concern, support for environmental policies, or awareness of environmental problems linked to transport, these approaches may better reflect group differences, should they exist. Recent work on environmental concern has begun to move away from the use of attitude statements (such as

the NEP), and move toward the use of personal values, which are a more stable and predictive construct (Steg, De Groot, Dreijerink, Abrahamse, & Siero, 2011; Steg & Vlek, 2009). Additionally, there have been suggestions that environmental issues may be open to self-report biases (Ewert & Galloway, 2009; Oerke & Bogner, 2011), and similar to some affective motives for car use, could require more implicit measures (Steg et al., 2001). Though the NEP (Dunlap et al., 2000) found no substantial differences between groups, alternative measurement methods may reflect the different environmental views suggested in Chapter 3.

#### **4.5.4 Mental Well-Being appears equal across travel mode groups**

The qualitative investigation in Chapter 3 suggested that some travel modes may also benefit a person's mental well-being. The concept of travel improving a person's subjective well-being, a measure analogous to mental well-being (Keyes & Lopez, 2002), has previously been suggested by Ettema et al. (2011), with some evidence that satisfactory transport trips were linked to increased subjective well-being (Jakobsson Bergstad et al., 2011). Additionally, systematic reviews suggest a positive relationship between physical activity and mental well-being for clinical samples (Stathopoulou et al., 2006) and older people (Windle et al., 2010), and some studies have suggested positive links for university students (Tyson, Wilson, Crone, Brailsford, & Laws, 2010) and office workers (Mutrie et al., 2002). To investigate possible links between mental well-being and travel mode choice, the survey included the Warwick-Edinburgh Mental Well-Being scale (Tennant et al., 2007), a measure with good validation when predicting poor mental health outcomes (Bartram, Yadegarfar, Sinclair, & Baldwin, 2011). Despite the evidence base behind physical activity and mental well-being, no significant differences between travel mode users groups was found; active mode users did not have significantly higher mental well-being scores. A possible factor might be the type of sample employed; a meta-analytical review of walking interventions and mental health found a positive relationship, though suggests this was only for clinical samples with severe depressive symptoms (Robertson, Robertson, Jepson, & Maxwell, 2012). Additionally, the survey is a one-time observation that may not capture possible improvement in mental well-being after using an active travel mode. As a high-level approach, the survey attempted to measure any differences among groups, but is unable to establish any causal links between physical activity and mental well-being. With uncertainty in results suggesting that either clinical or non-clinical samples can benefit from physical activity, and using an individual survey method, the results are not conclusive. Further research using experimental approaches may clarify this topic, though it currently appears that groups of travel mode users do not differ in their mental well-being.

#### **4.5.5 Limitations of personality measure and study design**

The attempted comparison of personality traits was unfortunately restricted by the measure's poor reliability. Using the Ten-Item Personality Index (TIPI: Gosling et al., 2003), scale reliability (Cronbach's  $\alpha$ ) of Agreeableness (.24) and Openness to Experience (.43) were well below the conventional level of .70 (Field, 2009). Even accounting for the debate of using a conventional Cronbach's  $\alpha$  level, with some researchers suggesting that values as low as .49 may be sufficient (Schmitt, 1996), results suggest serious problems that restrict their use. The TIPI has also been reported to show similar poor reliability by other researchers, again notably for the traits of Agreeableness and Openness to Experience (Romero, Villar, Gómez-Fraguela, & López-Romero, 2012). Reviewing short-scale personality measures, such as the TIPI, it appears that attempts using very brief scales may be fundamentally flawed; the GSOEP Big Five Inventory (BFI-S) which uses 15 items (Hahn, Gottschling, & Spinath, 2012) reports reliability for Agreeableness at .44, and the BFI-10 inventory of 10 items (Rammstedt & John, 2007) report low correlations against several established multi-item measures. Given the differences in affective appraisals, such as the high positivity and then either excitement or arousal for bicyclists or walkers respectively, comparisons of personality traits may further explain affective responses and desires across user groups. Any future work, however, will likely have to use more comprehensive and reliable personality measures before drawing any conclusions on this topic.

An important strength of this study is the large sample size. With 1,609 participants, the survey has good statistical power, and is representative of the university travel mode user groups, with no significant differences in proportion of responses from the four mode groups. This does challenge the generalisability of results to wider samples however. Respondents are likely to have higher education levels and socio-economic status than the general population: an important caveat given that low socio-economic status is linked to lower car use rates, more enjoyment of driving, and increased bus ridership (DfT, 2011). In addition, the university is not directly served by train services, nor accessible through underground/metro routes. Comparison between different forms of public transport, alongside bus use, could provide interesting results for the affective appraisals of the commute, or whether habit strength varies by public transport mode. Nonetheless, the size and breadth of the survey offers a range of useful results, which may generate ideas for future investigations.

#### **4.6 Conclusions**

This chapter was designed to complement the previous qualitative work, and describes an exploratory quantitative survey that compares users of four travel modes across a range of issues that arose in the previous focus groups. A replication of previous work (Gatersleben & Uzzell, 2007) using the core affect model (Russell, 2003) generally supported previous the

high satisfaction of active modes and low satisfaction for bus users, whilst more closely supporting the theoretical basis of pleasure and activation-based constructs. The first direct comparison of habit strength, across modes, suggests that active travel mode users have stronger habits than other modes, which may be linked to affective rewards that may act as a catalyst in habit formation. A surprising lack of environmental concern between mode groups was reported, which raises questions on how to measure the complexity of environmental concern. Mental well-being was also comparable across all groups, though further research on the role of physical activity and mental well-being is needed before any conclusions may be drawn. Lastly, a measure of personality was attempted, but issues emerged with the tool used. The survey offers a high-level overview of differences and similarities between travel mode user groups to facilitate discussion, and generate new ideas for future exploration within this thesis.



## Chapter 5: Replicating the Comprehensive Action Determination Model

*“ . . . Whether we try to push them onto buses or encourage car share or whatever we do . . . there’s a host of things we need to look at . . . ”*

- **Dave, Motorcyclist (119 -126)**

### 5.1 Abstract

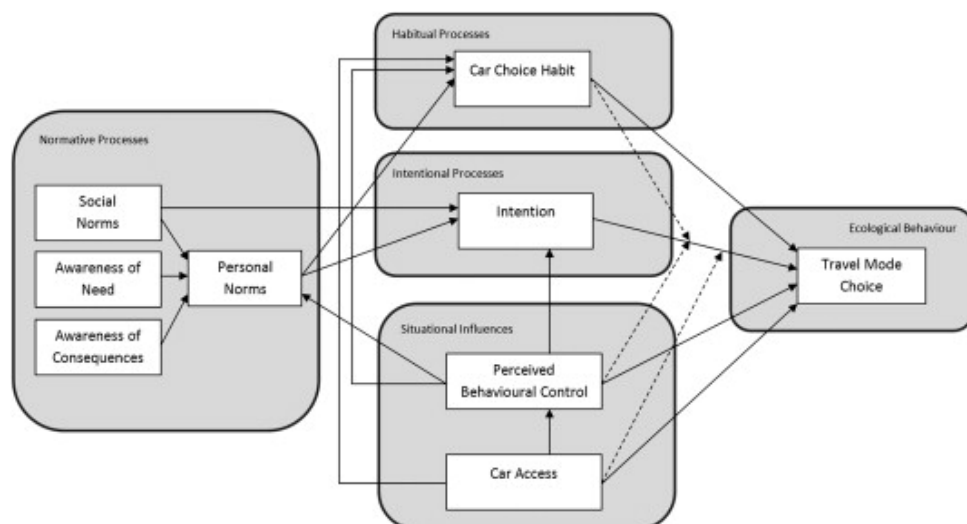
*A recently proposed framework for environmental behaviour proposed by Klöckner and Blöbaum (2010) combines rational-choice concepts of the Theory of Planned Behaviour (Ajzen, 1988; 1991) and the Norm Activation Model (Schwartz 1977; Schwartz & Howard, 1981), with the automaticity of Habit: the Comprehensive Action Determination Model (CADM). This chapter describes a replication of the original CADM using the 2011/12 University of Bath travel survey. The replication involved the use of Structural Equation Modelling: a multivariate statistical method combining elements of confirmatory factor analysis and multiple regression. Results were, however, mixed, and suggested several issues with the data collection that prevented a complete modelling of travel mode choice behaviour. In addition, the analytical procedure indicated a number of flaws with the design of CADM that suggests the model lacks a consistent pattern of analysis results or model structure, challenging the core concepts that define the CADM. The CADM shows some potential for combining automatic and reasoned concepts, but a more detailed integration of habitual influences may be required. Future work may develop the model further by demonstrating habitual influences upon cognition as well as behaviour, and may also integrate a temporal link between automatic and reasoned influences.*

### 5.2 Introduction

The previous chapters of this thesis sought to establish new areas of inquiry for research in travel mode choice. Establishing a new area for research requires consideration of previous work, and Chapter 2 outlined a variety of topics within transport psychology, including the range of automatic and considered factors that may influence modal choice. The array of different approaches to travel mode choice reflects the complexity of transport psychology as an applied approach, taking a number of different theories and models from across psychological research of social, health, and environmental psychology.

Within the range of theories, concepts and discussions of modal choice, some recent work has emerged that attempts to combine core concepts into a single, predictive model. Combining three key psychological theories while addressing the constraints of situational influences, Klöckner and Blöbaum (2010) published the Comprehensive Action

Determination Model (CADM) with the hope of detailed “*a more comprehensive conception of behaviour determination*” (p. 578). The CADM combines 3 main theories into a single framework designed to increase the amount of explained variability in behaviour by harnessing the influence of the separate constructs. First, the CADM uses the Theory of Planned Behaviour (TPB; Ajzen, 1985, 1991), one of the most popular models of predicting and explaining travel mode choice, and predicts around 28% of variance in travel choice behaviour (Gardner & Abraham, 2008; Sheeran, 2002). The TPB is a rational-choice model predicting behaviour directly from Intentions, which are formed by Attitudes, Social Norms and Perceived Behavioural Control (an applied locus of control for the behaviour). The second concept within the CADM is the Norm Activation Model (NAM; Schwartz, 1977; Schwartz & Howard, 1981) which focuses on moral obligation to perform behaviours, and has been demonstrated to be well linked to environmental behaviour (Bamberg & Möser, 2007). The NAM consists of a ‘Personal Ecological Norm’, which is predicted by a person’s awareness of the need to act, the consequences of their actions on the outcome in question, their perceived ability to act (directly comparable to PBC [Klöckner & Blöbaum, 2010] ), and how social norms influence a person’s norms. Third, the CADM includes automatic concepts by modelling the effect of Habit on behaviour. The automaticity of habits can interfere with rational decision models such as the TPB (Verplanken, 2006) and the NAM (Klöckner & Matthies, 2004), with increasing habit strength moderating the Intention-Behaviour link (Gardner, 2009). Lastly, the CADM includes situational influences: the objective ability to enact the behaviour in question. Combining these concepts, a representation of the CADM structure is shown in Figure 9.



**Figure 9: Outline structure of the Comprehensive Action Determination Model (CADM).**  
Adapted from “A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice” by Klöckner, C. and Blöbaum, A., 2010, *Journal of Environmental Psychology*, 30(4), p. 576. Copyright by Elsevier.

Christian Klöckner, the principle author, has since reported additional applications of the CADM for recycling behaviour in Norwegian students (Klöckner & Oppedal, 2011), student travel mode choice in Germany (Klöckner & Friedrichsmeier, 2011), and uptake of wood pellet heating for Norwegian householders (Sopha & Klöckner, 2011). In a more general application, Klöckner (2013) reported a Meta-analytic Structural Equation Model evaluation of the CADM using 56 datasets that included measure of the CADM components for sustainable behaviours. Each of these reports has indicated that the CADM is a successful model in explaining sustainable behaviour, from 36% of variance in behaviour explained in the meta-analysis of the CADM (Klöckner, 2013), to as much as 65% of variance in behaviour from the initial CADM report (Klöckner & Blöbaum, 2010).

However, the CADM has yet to be replicated by researchers not directly linked to Klöckner, and the combination of automatic and reflective components is of interest to my research interests. There is growing pressure in psychology to replicate previous work (Yong, 2012), and structural equation models have particularly low levels of replication (Kline, 2005). Coupled with the possibility that combining several models from automatic and reasoned perspectives may present an excellent opportunity to predict and explain environmental behaviours, I sought to replicate the CADM reported by Klöckner and Blöbaum (2010). In addition, with the opportunity to collect data from a large sample using the second University Travel Survey, differences between travel modes could be observed. In Chapter 4 survey analysis, habit strength was stronger for active travel mode users than car or bus users, but it is unclear how this may directly influence behaviour. Chapter 3 focus group analysis suggested strong environmental concern for active mode users, but with no differences found in Chapter 4, indicating an uncertain influence of environmental views on mode choice. With some surprising differences and similarities observed between groups in the exploratory research, the current chapter offers a more detailed investigation of how groups may differ in the pathways between concepts. Therefore, this chapter has two main goals. First, this chapter describes a replication of the Comprehensive Action Determination Model (Klöckner & Blöbaum, 2010) using a new sample. Second, the model will compare how different user groups compare within the model pathways to further evaluate group differences in modal choice, and antecedents thereof. It is hypothesised that users of different travel mode user groups will show significantly differences within the CADM, reflecting the differences found in earlier explorative work.



## 5.3 Study 3

### 5.3.1 Ethical Approval

Approval was granted by the University of Bath Department of Psychology ethics committee, Ref: 12-141.

### 5.3.2 Method

As described in Chapter 4, the University of Bath is committed to biennial surveys of staff and student travel, and the second survey was used for this chapter. The design and development of the second survey is extremely similar to the first survey detailed in Chapter 4, and only a brief description is offered here. The survey ran throughout November 2012, and was advertised by emails to all staff and students currently based at the University, and through posters and digital signs across campus screens (Appendix C). The survey was built using SurveyMonkey.com, with a prize draw of two £75 vouchers for one staff member and one student as an incentive. The survey consisted of standard questions on travel-related topics (main mode, distance, satisfaction with facilities, etc.) before asking if people consented to a brief psychology section.

### 5.3.3 Measures

The CADM proposed by Klöckner and Blöbaum (2010) used 28 questions to collect data on the 8 concepts in their model, and as a replication, I wanted to take a similar approach by using two or three questions per item. However, some necessary changes were made to better reflect the concepts being measured, and to accommodate several different travel mode users.

Measuring habit strength in the CADM was originally a combination of 5 items on the Response Frequency Measure (Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994) and 6 items from the Self-Report Habit Index (Verplanken & Orbell, 2003). The Response Frequency Measure or RFM (Verplanken et al., 1994) was not included in the current study, as it relies on time-constraints for responding, which would not be possible in an unsupervised survey. Instead, the 12-item SRHI (Verplanken & Orbell, 2003) was used as the more popular and validated measure of habit (Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007). The CADM reported by Klöckner & Blöbaum (2010) used some differences in language for SRHI items than originally suggested by Verplanken and Orbell (2003), and the original phrasing was used here. For example, the SRHI item *“Using the car for frequent trips is something that’s typically ‘me’”* was reported in the CADM (2010) as *“Using the car for frequent trips is something that is typical for me”*.

For items relating to TPB (Ajzen, 1985, 1991) and NAM (Schwartz, 1977; Schwartz & Howard, 1981) concepts, CADM questions directly related to car use. With a range of mode choices available, it was decided that the current survey would focus upon each

respondent's stated main mode: e.g., bicyclists would receive questions on bicycling intentions, not car use intentions. The objective was to observe whether pathways leading to a mode decision within the CADM framework would be different, for example, between bicyclists and car users, rather than explore bicyclist's (or other mode) views on car use. For the TPB items, wording was changed to suit participant's specified mode mentioned earlier in the survey. In addition, the CADM (Klöckner & Blöbaum, 2010) did not include Attitudes as a predictor, but was measured in the current survey using 3 items on the favourability of the current mode choice, including one negatively scored item, based upon instrumental and experiential views as recommended by Ajzen (2002).

For the NAM, the original CADM (Klöckner & Blöbaum, 2010) questions examined respondents' views linking car use to environmental damage. The current survey expands to a range of modes, and given the minimal damage of active modes to the environment, asking respondents to evaluate their negative influence upon the environment would likely be imbalanced. Instead, the current survey asked participants to evaluate the link between transport emissions and the environment as a general measure of awareness and concern.

To measure behaviour, the CADM (Klöckner & Blöbaum, 2010) used a seven day travel diary after the survey was completed, and used a proportion of car trips used for all trips undertaken as a measure of behaviour. Of all trips undertaken, the number of trips used by the respondent's specified main mode was used as a proportion. The current replication of the CADM was limited by a one-time survey, and instead of a post-survey follow-up measure of behaviour, a retrospective seven-day travel diary was used. Unfortunately, this meant that future intentions are used to predict past behaviour, which is theoretically problematic (Steg & Nordlund, 2012). Retrospective travel diaries have been successfully employed by other researchers when examining TPB models (Harland, Staats, & Wilke, 1999; Heath & Gifford, 2002), and although the stability of commuting behaviour should maintain links between intentions and behaviour (Ajzen, 2002, p. 111), results should be interpreted with caution.

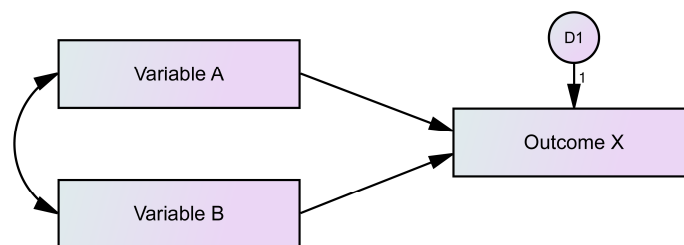
#### **5.3.4 Introducing Structural Equation Modelling**

Structural Equation Modelling (SEM) is an incredibly complex area of statistics that includes a wealth of new terms, methods and assumptions (Ullman, 2013). There is also very little consensus in the use of methodology, terminology, and evaluation, so I will attempt to describe the most popular terms used and identify my preferred uses. Additionally, explaining SEM can be accomplished in a number of different ways, and the description offered here details the principles I found to be the most informative. First, key applications/variations of SEM will be described, before highlighting the steps of SEM analysis, and then discussing the analysis results. The intention is to provide a working description of SEM to allow interpretation of results, though this chapter will not be able to cover all of the complexities

within SEM. Key reference sources for performing the analysis were the highly useful works by Norman and Streiner (2003) and Kline (2005) for describing types of SEM, Blunch (2008) and Byrne (2009) for programming within AMOS, and also Schumacker and Lomax (2010) and Ullman (2013) for theoretical considerations. Those interested in SEM may refer to authors listed above, with the former names indicating more introductory work, and the latter names for more in-depth principles of SEM.

#### 5.3.4.1 Path Analysis Model

To illustrate the 3 main types of SEM, we'll start with a basic example. Assume we want to predict Outcome *X* from two variables (*A* and *B*). This relationship can be drawn as a *structural model* using the widely-used conventions of SEM based upon *reticular action modelling* (McArdle & McDonald, 1984), shown in Figure 10 below.



**Figure 10: Example of a path analysis model, with two observed exogenous variables predicting the observed endogenous variable with an unobserved disturbance term**

The convention for structural models is to use rectangular (sometimes square) boxes for variables we have measured/observed. Figure 10 includes our two predictor variables (*A* and *B*) that we have observed, and are *exogenous* because their causes lay outside of our model (and, by extension, our theory). Variables *A* and *B* are joined by a curved, double-headed arrow which signifies covariance between the two, suggesting the two are linked, though we make no causal assumptions of directional relationship. The predictor variables are linked to Outcome *X* by straight, one-headed arrows known as *paths*; these indicate theorised direct effects upon the outcome from the variable. It should be noted that a double-headed arrow can be curved or straight; a curved path indicates covariance, while a straight path implies a direct effect. A straight double-headed path would indicate that both variables have a direct effect on each other as a feedback loop. Paths are assessed using path coefficients, interpreted as regression coefficients (as in multiple regression), and control for correlations between predictors (Kline, 2005); for example, the path Variable *A* → Outcome *X* controls for correlation between Variable *A* and *B*. Outcome *X* is an observed variable described as *endogenous* as the causes are directly described within the model.

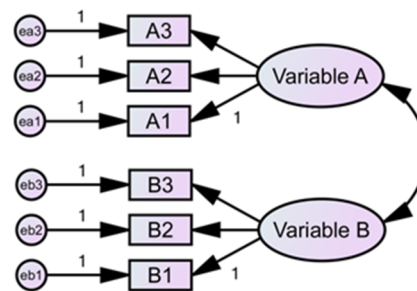
Of interest is the circle attached to Outcome *X*. Circles and ellipses denote *latent* variables: also known as ‘*unobserved*’ or ‘*unmeasured*’ (Byrne, 2009, p. 15), or sometimes as ‘*constructs*’ or ‘*factors*’ (Schumacker & Lomax, 2010, p. 180). In SEM, latent variables are

properties we cannot directly see or record. In this case, the latent variable “D1” represents *disturbance* ( $\delta$  or D). When we create a model, we cannot assume perfection, since the real world has unknown variables that could confound our model. We represent this unknown disturbance with a latent variable, indicating the influence of outside variables, and consider this influence as purely random and non-systematic to our model (Blunch, 2008). Disturbance exists for every endogenous variable, it is analogous to residuals in multiple regression, and is sometimes displayed with a double-headed covariance link connected to itself to indicate the role of an exogenous variable (Kline, 2005).

Path Analysis can test theorised relationships between variables, testing potential causal relationships. The use of straight lines with arrow heads led to the rise of Path Analysis to be known as a causal model (Norman & Streiner, 2003), though more recent works take care to note that causality in SEM is attributed by design, and not demonstrated statistically (Ullman, 2013). Developed from multiple regression methods (Norman & Streiner, 2003), Path Analysis allows greater complexity – a variable may be both a predictor and criterion in a complex model of interactions (Kline, 2005) opening more possibilities for research than conventional analyses.

#### 5.3.4.2 Confirmatory Factor Analysis (a.k.a. The Measurement Model)

Continuing the example from Path Analysis, a second application of SEM is the use of Confirmatory Factor Analysis (CFA) to establish the measurement of latent variables, which are unmeasurable by a universal and objective method. Examples of latent variables could include: Intelligence, Personality, Depression, Satisfaction, or Habit. Instead we can infer the properties of these variables by using different items/variables, such as questions on a survey. CFA allows us to determine how well these individual items link together to form a composite measure of a latent variable.



**Figure 11: Example of a confirmatory factor analysis model with two latent variables, each with 3 indicator variables with their measurement error terms**

Figure 11 illustrates a CFA structural model. As with Figure 1, ellipses highlight a variable as latent, though we now consider Variable A and B to be latent variables. Again these items are

linked by a double-headed curved arrow which indicates the same relationship (non-specific direction covariance) in Figure 10.

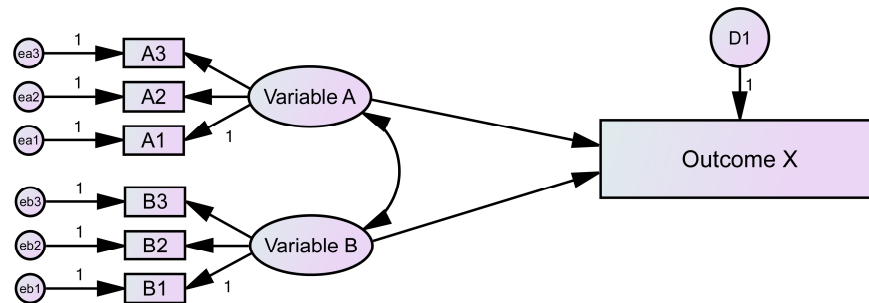
The square boxes linked to each variable represent our measured variables; confusingly known by a mixture of different names; '*indicator*' (Byrne, 2009, p. 25), '*measured*' or '*observed*' (Schumacker & Lomax, 2010, p. 182), or '*manifest*' (Blunch, 2008, p. 5) variables. For this chapter, I will use *indicator variable*. For latent Variable A, let's imagine we have 3 indicator variables which reflect 3 different questions on a survey we theorise will generate a value for our latent variable. Using multiple predictors is advised, because using individual items to infer the unknown latent variable value is likely prone to error (systematic or random), and each indicator variable may measure different aspects of the latent variable (Kline, 2005). Although we use the indicator variables to determine a latent variable, the structural model shows paths from the latent to each indicator variable; the same concept of a causal link applies, with the latent variable presumed to have a direct link on the indicator variables. In CFA, these path values are described as *factor loadings*, again interpreted as standardized or unstandardized regression coefficients (Kline, 2005). As in Figure 10, observed values (our indicator variables) have unique latent variables shown by circles, known as the *measurement error* ( $\epsilon$  or  $e$ ). The measurement error terms, like disturbance, are proxies for all un-accounted for variation in indicator variable scores not accounted for by the latent variable (Kline, 2005). The value of 1 given to each measurement error defines a common metric to each residual. The value of 1 assigned to the path Variable A  $\rightarrow$  AI is also a metric, setting a baseline to gauge the links from Variable A to the other indicator variables.

Also notice that Outcome X is not included in the CFA – as an observed variable we do not need to consider how well it is measured by individual items. The disturbance term acts as a proxy representing unmeasured error, and is accounted for (Kline, 2005, p.69).

The CFA model indicates how well the theorised link between indicator and latent variables works. It establishes if indicators have a sufficient link to the latent variable, and that the latent variables are not too similar to avoid a meaningless separation of indicator variables (Kline, 2005).

### 5.3.4.3 Structural Regression Model (a.k.a. Full SEM, Hybrid Model, or LISREL model)

The two SEM methods above can be combined into one complete model known by a variety of different names, but will be known as a Structural Regression (SR) model for this chapter. Completing the example, the SR model combining Figures 10 and 11 is shown below:



**Figure 12: Example of a structural regression model, combining the CFA of the two indicator variables, and their prediction of the observed variable with error term**

Figure 12 combines the CFA and Path Analysis into one model, and the terms and symbols shown should be familiar. Variables *A* and *B* are now latent variables, each informed by 3 indicator variables, and are predicted to have a direct effect upon Outcome *X*, while allowed to co-vary.

A CFA model can clarify if indicator variables are suitably linked to a latent variable, and a Path Analysis model can evaluate if there are causal links between variables. What SR models offer is the chance to explore causal links using latent variables that don't assume the measurement is without error, as Path Analysis does (Kline, 2005). Since the error in SR models has been estimated and removed, the reliability of measurement increases, and we can assume only common variance between factors remains (Ullman, 2013).

### 5.3.5 Establishing Structural Equation Modelling

Describing a SEM procedure can be difficult because of the number of considerations and steps involved. For this chapter, the five-step procedure by Schumacker and Lomax (2010) is presented, with discussion of the research decisions appropriate to each step. The five-step approach for SEM can be viewed as:

1. Model Specification
2. Model Identification
3. Model Estimation
4. Model Testing
5. Model Modification

Firstly, **Model Specification** is the precursor to analysis, which involves developing the theoretical basis of the model. The theory determines which variables are to be included, and how these variables will relate to each other: in essence, drawing a model to explain something. At this stage the goal is to establish a framework that best suits the true population framework, to design a theorised link between concepts to explain and predict the behaviour. This stage is usually seen as the most difficult part of the SEM process because of detailed theoretical work (Schumacker & Lomax, 2010), though fortunately as I am replicating previous work, the model specification has already been determined by Klöckner and Blöbaum (2010), with additional supplements by Klöckner (2013).

The second stage of SEM is **Model Identification**, which focuses on whether unique values for each parameter in the model can be found; it is one thing to draw a structural model, but another to see if the model is actually possible. The issue of identification is based on theoretical possibility; even if a dataset has 100 or 1,000 observations, an undefined model will not function (Kline, 2005). An example by Schumacker and Lomax (2010) is the model  $X + Y = 10$ , where the values of  $X$  or  $Y$  could equal almost any pair of values to equal 10. This example model suffers from indeterminacy; the data can fit more than one implied model, and the model is too vague to have a meaningful outcome, and is *under-identified*. In practice, there are not enough observations, or results, to define the model, so the degrees of freedom is negative (Kline, 2005). Adding another equation, so that  $X - Y = 2$ , then the two equations have only one possible outcome ( $X = 6$ ,  $Y = 4$ ) with no possible room for error: the model is now *just-identified*, and degrees of freedom equal zero. Blunch (2008) expands this example to suggest this just-identified can be tested by adding another equation:  $X \times Y = c$ . There is now an unknown in the equation so the model is *over-identified*; the model may be correct if  $c = 24$ , but if  $c \neq 24$  then the model is not correct. There are now positive degrees of freedom, which is a desirable outcome for SEM researchers as it allows more precise estimation and increases the power of the test (Blunch, 2008). Alternatively, if  $c = 18$ , there is no perfect solution, but a solution can be found by imposing statistical rules for unique estimates to derive a result as closely fit as possible. Imposing rules on models to obtain the smallest error from observed values is a solution to the over-identification problem (Kline, 2005). Three types of parameter constraints exist; *free* parameters are unknown and open to vary, *fixed* parameters has a certain value (typically 0 or 1), and a *constrained* parameter is unknown but constrained to equal another parameter or series of parameters.

Thirdly we consider **Model Estimation**, where we estimate the parameters in the model, and begin to establish how well the model emulates the data. Using the data collected, we calculate the Sample Covariance Matrix, or  $S$ . We begin with a data matrix  $X$ , containing the values for each observation (as rows) on each variable (columns). Then using algebraic

functions, data matrices of each variable are combined to create the Sum of Squares and Cross Products, or SCCP matrix, and also known as the matrix  $C$ . The matrix  $C$  can then be used, as we divide all elements by the degrees of freedom ( $n-1$ ). The division of all elements in  $C$  gives the Covariance Matrix  $S$  containing all the covariance and variance of the variables. This brief foray into matrix algebra is required since  $S$  is our total sample covariance, and SEM is the process of creating a model covariance matrix ( $\Sigma$ ) to be compared against  $S$ : the better our model  $\Sigma$ , the less discrepancy we have with matrix  $S$  (Schumacker & Lomax, 2010). Comparing  $\Sigma$  and  $S$  requires a *fitting function*, a highly complex mathematical procedure analogous to the least square criterion of multiple regression (Kline, 2005), of which there are several versions available. For brevity, Blunch (2008) advises the use of the commonly-used Maximum Likelihood method as the preferred method, and using other methods generally requires detailed justification (Kline, 2005), though see Schumacker and Lomax (2010) or Ullman (2013) for evaluations of alternate methods. For the current analysis, Maximum Likelihood will be used.

The fourth stage is **Model Testing** which involves the direct testing of the theoretical model  $\Sigma$  and interaction of parameters against the actual, observed data,  $S$ . There are two different types of test that can be run to evaluate the model. Firstly, a global test (similar to the F value in ANOVA-type analysis) can be performed to check the model  $\Sigma$  with the sample covariance matrix  $S$  (Schumacker & Lomax, 2010) known as a model-fit index. Unfortunately, dozens of model-fit indices exist and the area is under constant change and revision (Ullman, 2013). The sheer number of indices makes it difficult to compare across SEM research, and can lead to unscrupulous researchers pick better-fitting indices to support their models (Kline, 2005). Indices vary in their methods; some compare the fit of the model against alternative models that use different assumptions, some assess the absolute fit of the model against the covariance matrix  $S$ , some indices consider the degree of parsimony or simplicity within the model (often applying a Parsimony Ratio to other indices), and other indices are based on residuals from the model. Detailed discussions of the comparative indices can be found in detailed guides to SEM (Blunch, 2008; Byrne, 2009; Ullman, 2013).

With a “smorgasbord” of indices (Byrne, 2009, p.83), choosing which indice to report is a matter of personal preference (Ullman, 2013) and consideration of the model (Blunch, 2008). It is also advised to report several indices to demonstrate the full complexity of the model (Schumacker & Lomax, 2010). In this analysis, the following indices were chosen:

1. Chi Square ( $X^2$ ) statistic with df and significance.

An absolute fit index, it assesses how closely the model fits the sample covariance matrix (Kline, 2005). Although deeply flawed with large sample sizes (Blunch, 2008; Byrne, 2009), it remains the most popular statistic to report (Kline, 2005) and is often



recommended for inclusion as the only model fit index with a significance test (Blunch, 2008; Schumacker & Lomax, 2010).

2. Comparative Fit Index (CFI).

A comparative fit, also known as an incremental fit index, CFI compares the prescribed model with a null-model that contains no covariance (Kline, 2005). A commonly reported statistic (Ullman, 2013), CFI is recommended for reporting by several statisticians (Byrne, 2009). A measure of how close the model fits to the covariance matrix  $S$  that also accounts for sample size (Blunch, 2008), values  $>.95$  are thought of as good (Hu & Bentler, 1999), values  $>.90$  are generally acceptable (Kline, 2005), and values  $<.80$  are problematic (Blunch, 2008).

3. Root Mean Square Error of Approximation (RMSEA)

An absolute fit index that can be interpreted as a “badness of fit” (Kline, 2005, p. 205), RMSEA offers a value of comparative fit encouraged for accuracy in common interpretive guidelines (Hu & Bentler, 1999). It is sensitive to model misspecification and can have confidence intervals calculated to help interpretation (Byrne, 2009) with the convention for 90% confidence intervals (Kline, 2005). Values  $<.06$  are good (Hu & Bentler, 1999) and values  $>.10$  are poor (Blunch, 2008).

4. Standardized Root Mean Square Residual (SRMR )

Another absolute fit index, as a metric of residuals, the standardised version of the RMR allows for differences between measurement scales (Ullman, 2013). SRMR is particularly useful if some scales have been transformed, as described later in this chapter. This measure is advised for inclusion alongside comparative fit indexes (Hu & Bentler, 1999) with values  $<.08$  seen as good (Kline, 2005).

5. Parsimony ratio corrected CFI (PCFI)

Overly-complex models can saturate the model producing better fit indices (Crowley & Fan, 1997). In response, a family of Parsimony fit indices have been developed, normally based around previous indices, that punish overly-complex models (Blunch, 2008). In addition, the original model by Klöckner and Blöbaum (2010) didn't report a parsimony-based index, and it would be useful to determine if their model is overly-complex. Parsimony based values of  $>.60$  are considered good (Blunch, 2008).

I should note that I will not use the General Fit Index (GFI) or AGFI (Adjusted GFI for number of parameters) for absolute fit of the model. Though the GFI is analogous to the  $R^2$  value of multiple regression (Blunch, 2008) and useful for interpretation, these indices can be heavily influenced by large or small samples and are not recommended for use (Sharma, Mukherjee, Kumar, & Dillon, 2005), despite being very popular and historically tied to SEM origins (Blunch, 2008).

The second test of a model examines individual parameters within the model. Parameters are tested to determine if a link between two concepts is statistically significantly different from 0, whether it agrees with the theoretical link between two concepts, and delivers a sensible value, e.g. a correlation less than 1.0 (Schumacker & Lomax, 2010). This secondary assessment is more akin to standard statistical inference, based upon path coefficients and  $R^2$  values as with multiple regression (Kline, 2005).

The final and fifth stage is **Model Modification**: the alteration of the model to find the most beneficial structure and increase applicability of the model to the results. A number of procedures are available to perform a *specification search* to highlight inefficient parameters. Procedures may include searching for non-significant parameters, though this needs to be considered in light of sample size and whether parameter strengths can reasonably be explained in theory (Schumacker & Lomax, 2010). The best practice for modifying the model after testing can be problematic, with no consensus on the best approach (Schumacker & Lomax, 2010). A popular method, offered by Amos, is the use of Modification Indices (MI). A list of MI scores are calculated by Amos that indicate how much the chi-square value of the model will fall (indicating reduced error between the model and the data), and the estimated change in the parameter estimation, if the suggested additional factor is added to the model. Additional factors include adding covariances between measurement error terms or variables, or adding/removing regression coefficients from variables (Byrne, 2009). For the current study, the option of removing variables is troublesome since there are so few predictors, and adding regression lines would violate the replication of the CADM. Therefore, specifying covariance between variables is the best choice. Adding covariance between error terms is based on the principle that if measurement errors are random, then the shared covariance is linked to an underlying factor being measured. If measurement errors do covary, this could reflect an alternative influence over the indicator variables (e.g. assessment method issues) and adding a covariance term controls for this influence (Cole, Ciesla, & Steiger, 2007).

However, suggestions in Amos are not supported by any probability test to indicate if the modification gives a significant benefit, and MI values from Amos are interpreted mainly by considering their contextual size (e.g. Byrne, 2009, p.114). While MI are endorsed by a number of scholars (Blunch, 2008; Schumacker & Lomax, 2010), it is advised that the fewer modifications the better (Ullman, 2013). Also, though tempting to covariate any items to improve model fit, any modification must make theoretical sense (Blunch, 2008; Kline, 2005; Schumacker & Lomax, 2010) and must be justified appropriately. Any changes to the model should also be evaluated individually, with the model re-tested after each MI is added, since

estimated values only reflect individual changes (Blunch, 2008), and a stepwise approach will be taken here.

### **5.3.6 Performing Structural Equation Modelling**

After describing the basics of SEM, and the theoretical steps in calculating SEM, I can now discuss my actual application of SEM to my research question. Though the 5 steps by Schumacker and Lomax (2010) cover the high-level statistical concepts, Anderson and Gerbing (1988) offer a more practical two-step method for analysis. The two-step method is to first assess a measurement model for the latent variables, and then to assess the full Structural Regression (SR) model for connections between variables. The value of the two-step process is the ability to spot where problems occur in defining unobserved latent variables, and detaching this from the theorised relationships between variables (Byrne, 2009). In addition analysis will follow the method used by Klöckner and Blöbaum (2010) by first building the Theory of Planned Behaviour (TPB), then the Norm-Activation Model (NAM), combining the two models, and then adding Habit and 'access to mode' to form the complete Comprehensive Action Determination Model.

### **5.3.7 Participants**

The total number of respondents who started the survey was 2,711. With mass email to all staff and students at the University, directly calculating a response rate is difficult. However, when considering the number of people who agreed to the psychology section of the survey, 67.9% of respondents took part, 26.2% refused, and 8.6% gave no response. This left 1,843 respondents, of whom 378 had also not given a main mode of travel, leaving 1,465 respondents. Included in the remaining participants were 21 motorcyclists, 65 train users, and 5 miscellaneous mode users. With very small numbers, these participants were dropped from the analysis, leaving 1,375 respondents using four main travel modes: 145 Bicyclists, 529 Bus users, 529 Car users, and 172 Walkers.

#### ***5.3.7.1 Data Cleaning***

Missing data is problematic for SEM; Maximum Likelihood estimation assumes no missing values (Kline, 2005), and so must be dealt with. Missing data were considered for all TPB, Habit, NAM, and Autonomy variables; 39 variables in total. With 1,375 participants, this generates 52,250 data points. A total of 235 data points were missing for a total representation of 0.005% of missing cell values, and each variable had <1% of values missing, and 1199 cases, or 87.1% of the sample, had no missing values. Little's MCAR test found values to be Missing Completely At Random (MCAR), indicating no evidence of systematic bias in missing values,  $\chi^2(2495) = 2564.671$ ,  $p = .162$ . With missing data MCAR, and 12.9% of

cases with missing data, using complete case analysis is an acceptable method (Hardy & Bryman, 2004; Schafer, 1997).

Removing cases with missing data led to a total sample size of 1199, shown in Table 5. The next step is to consider distributions, outliers, and whether transformations are required. When cleaning data, it is recommended that transformations take place before assessing for multivariate outliers, as multivariate outlier tests are also influenced by non-normality (Tabachnick & Fidell, 2013). Normality assumptions are important within SEM, as the Maximum Likelihood method of estimation assumes normal distributions (Kline, 2005). With 39 variables, varying levels of skew were observed in each variable. To address the problem of skew, transformations were carried out for sets of variables where appropriate. For example, the NAM-related variable of “Awareness of Need” (AN) showed all three predictors had a strong positive skew, and were all transformed using natural log. Applying the transformation to all 3 variables in AN allows the three to be aggregated, if required, into one variable. Other sets of variables, such as NAM construct of “Personal Ecological Norm” (PEN) showed only minor skew, where transformations only increased the skew, and remained in the original metric without transformation. Where variables indicated positive skew, natural log( $x$ ) transforms were used. Transforming the data with a negative skew required reversing the scores (Tabachnick & Fidell, 2013), using the general formula:

$$X' = (X_{max} + 1) - X$$

Where  $X_{max}$  is the highest value of variable  $X$ . The formula mirror flips the distribution creating a positive skew, which can then be transformed using the natural log method. Once transformed, these reversed scores were then reversed again (using the formula  $Z_{max} - Z$ , where the  $Z_{max}$  is the highest value after transformation), to restore the original metric of a higher value reflecting a higher score on that variable<sup>12</sup>. Results from the transformations, with pre/post skew scores and type of transformation are shown in Appendix D.

I then wished to check for the presence of outliers that may influence results. When detecting outliers in one variable, the common method is to examine how many standard deviations results fall, and remove those higher than 3 SD in large samples. Using multiple variables requires calculating the Mahalanobis distances ( $D^2$ ) which is a multi-dimensional version of a  $z$  score that measures the distance of an observation from the centroid of the multivariate distribution (Tabachnick & Fidell, 2013). These were created in SPSS by running a linear regression model with each of the 38 variables as predictors, requesting the

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<sup>12</sup> The SPSS syntax was inevitably  $1.95 - (\ln(8 - X))$ , since all variables had max values of 7, which became 1.95 after  $\ln(x)$

Mahalanobis distance to be saved. The regression model output isn't important and the Independent Variable was arbitrarily chosen: the important result is the distance calculated. The significance of each distance is calculated using a chi-square distribution test, calculating a new variable for each case using the CDF.CHISQ(?,?) command in SPSS, defining the calculated Mahalanobis distance for the first argument, and the degrees of freedom for the second argument, which is the number of variables minus 1. Mahalanobis distances are assessed using probabilities of less than 0.001 to classify observations as potential outliers (Tabachnick & Fidell, 2013). Calculating Mahalanobis distances using the 39 predictor variables indicated 57 cases with significant distances ( $p < .001$ ), and were excluded from analysis. The whole process of cleaning data removed 291 observations from the dataset, with figures for the total numbers and numbers using main modes shown in Table 5 below.

**Table 5: Process of cleaning dataset for complete CADM variables**

Mode	Full Set	=>1 Missing Value (234 removed)	Outliers (57 removed)
Bicycle	145	126	123
Bus	529	466	445
Car	529	454	427
Walk	172	153	147
Total	1375	1199	1142

The final sample for bicyclists had a mean age of 30.8 (SD = 12.6), mostly male (27% female) and mostly students (41.5% staff). Bus users had a mean age of 23.9 (SD = 7.72), were mostly female (60.8% female), and predominantly students (14.4% staff). Car users had a mean age of 40.3 (SD = 12.5), the majority were female (63.6% female) and largely composed of staff members (80.6%). Walkers had a mean age of 28.7 (SD = 11.1), with slightly more males (44.2% female) and the majority were students (63.9% staff).

#### **5.3.7.2 Sample Size and Power**

There are no certainties with the required sample size in SEM. Kline (2005) offers rough guidelines where <100 participants is small, 100-200 is medium sized and >200 is large. Kline (2005) also describes a desirable ratio of 20 participants : 1 free parameter, with a realistic target of 10 participants : 1 free parameter (free parameters are values to be estimated in the model). In the full CADM there are 96 free parameters to estimate, so the current sample size of 1142 is within the realistic (though not ideal) ratio of approximately 12:1.

Another consideration is the Hoelter Critical  $N$  value offered by AMOS that computes the required sample size to reject the current model (Schumacker & Lomax, 2010), similar to Rosenthal's (1979) failsafe  $N$  value used in meta-analyses. For the final CADM model described later, Hoelter's Critical  $N$  at  $p < .05$  was 198, just shy of the suggested benchmark of

$\geq 200$  (Schumacker & Lomax, 2010) suggesting the current sample size is approximately adequate for the model.

An alternative and more powerful post-hoc power analysis is possible using a method based on RMSEA values (Kline, 2005; Schumacker & Lomax, 2010). Post-hoc SEM power analysis assesses the power of the sample using 3 different hypotheses: there is an exact fit of the model to the population; the model has a close fit; or the model does not have a close fit. The exact fit test is sometimes seen as implausible and not included (Kline, 2005) but included here for interest. A higher power for the close fit hypothesis indicates better ability to reject an incorrect model, and higher power for not close fit hypothesis suggests improved ability to detect a correct model (Kline, 2005). In effect, the not close fit hypothesis is the conventional test for power; observing the ability to detect an effect if it exists, also known as the ability to prevent Type II errors. Calculating power requires a syntax command in SPSS, taken from Schumacker and Lomax (2010), shown in Appendix E. Using the final CADM model results, the three hypotheses were tested and results shown in Table 6.

**Table 6: Power analysis results based upon MacCallum et al. (1996) Null and Alternative Hypothesis values for RMSEA for full SR-SEM model of the CADM ( $\alpha = .05$ ,  $df = 499$ ,  $N = 1142$ ).**

	H <sub>0</sub>	H <sub>a</sub>	Power
Exact	.00	.05	.05
Close	.05	.08	1.00
Not Close	.05	.01	.54

Kline (2005, p.158) notes SEM power analysis results can be “sobering” (p.158), and results here support this. The observed power of the final model to detect an effect if it exists (the not close hypothesis) was .54 and below the conventional level of .80. Even with 1142 participants, CADM analysis requires even greater sample size for a conventional level of statistical power. For comparison, using the original CADM report with 389 participants and 151 degrees of freedom, gives a power (for the not close hypothesis) of .09, implying a more serious deficit of statistical power.

## 5.4 Results

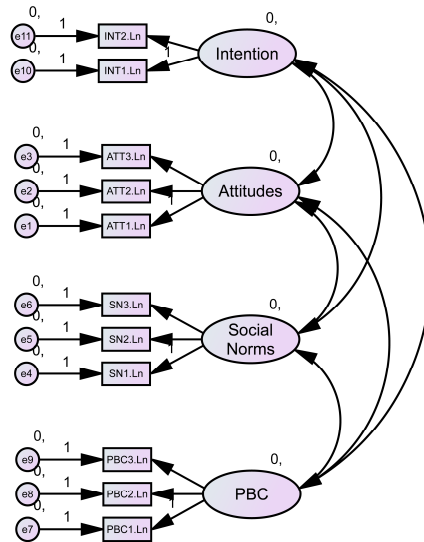
Once data were transformed for approximately normal distributions, and with outliers removed, data were ready for the first of two stages for SEM recommended by Anderson and Gerbing (1988): creating a measurement model using Confirmatory Factor Analysis (CFA) to assess how well the variables link to the latent construct in question

### 5.4.1 Constructing the Theory of Planned Behaviour

With the four latent variables allowed to co-vary, and the manifest variables described above linked to each latent variable, CFA was run. The CFA for the TPB latent variables found a

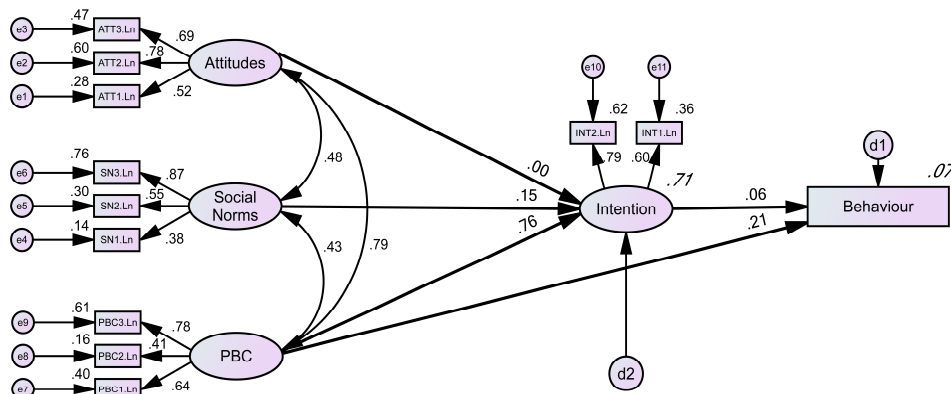
solution;  $\chi^2 (38) = 269.84, p < .001$ , CFI = .93, RMSEA = 0.73 (90% .065 to .081), SRMR = .05, PCFI = .641. Results suggest the model is a fairly good fit of the data.

While some modification indices proposed a reduction in  $\chi^2$  (MI = 44.48), this was between the PBC2 and latent Attitudes, which makes little theoretical sense. Coupled with an acceptable model fit, I was content not to make adjustments to the CFA model at this point. To illustrate the relationships between latent and manifest variables in CFA measurement model, Figure 13 displays how the analysis was set up.



**Figure 13: Path diagram of CFA measurement model for the TPB latent variables**

For each step of the analysis in constructing the CADM, additions are made to the CFA models to account for the inclusion of new latent variables. To conserve space, these models will not be shown, but are all extensions of Figure 13. With a satisfactory measurement model, SEM analysis was applied to establish links between the latent variables. Results from a full Structural Regression Model for TPB variables are displayed on Figure 14. The model fit was found to be acceptable;  $\chi^2 (47) = 368.97, p < .001$ , CFI = .91, RMSEA = .077 (90% .070 to 0.85), SRMR = .05, PCFI = .64.



**Figure 14: SR Model pathways for the TPB variables, with standardised regression coefficients shown**

With detailed results in Table 7:

**Table 7: Detailed results from SR analysis of the TPB model**

Model Link	B	S.E	<i>p</i>	beta	Model Link	B	S.E	<i>p</i>	beta	R <sup>2</sup>
ATT → ATT1	.734	.049	<.001	.525	BEH → INT	.041	.060	.497	.062	.07
ATT → ATT2	1.193	.061	<.001	.776	BEH → PBC	.138	.058	.018	.213	
ATT → ATT3	1.00	-	-	.689	BEH					
SN → SN1	.436	.044	<.001	.378	INT → ATT	-.002	.088	.982	-.002	
SN → SN2	.686	.057	<.001	.547	INT → SN	.136	.037	<.001	.153	.71
SN → SN3	1.00	-	-	.871	INT → PBC	.757	.093	<.001	.764	
PBC → PBC1	.810	.043	<.001	.636	INT					
PBC → PBC2	.633	.052	<.001	.405						
PBC → PBC3	1.00	-	-	.781						
INT → INT1	.686	.041	<.001	.603						
INT → INT2	1.00	-	-	.788						

Results suggest that despite a very large amount of variance explained for Intentions (71%), the link between Intentions and Behaviour was non-significant ( $p = .497$ ).

#### 5.4.2 Constructing the Norm-Activation Model

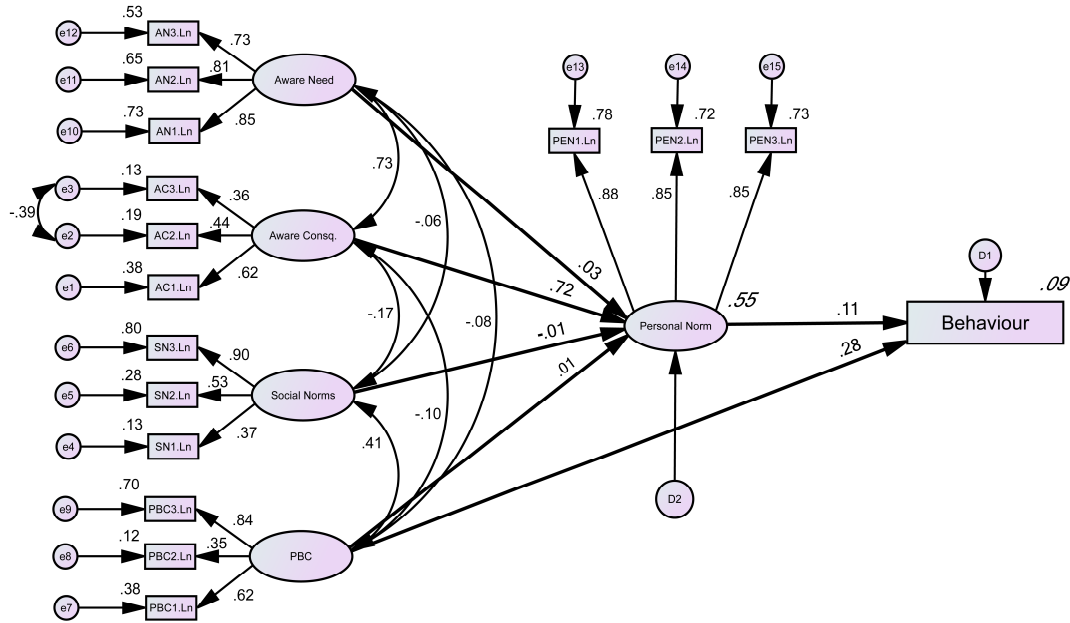
The lack of a significant link between intentions and behaviour is a surprising result, and may be a cause for concern, and is evaluated in more detail in section 5.4.6 of this chapter. Continuing with the replication of the CADM, the analysis then evaluated the Norm Activation Model (NAM; Schwartz, 1977; Schwartz & Howard, 1981). The first step is to establish the CFA measurement model, containing the latent variables for Personal Ecological Norm, Awareness of Need, and Awareness of Consequences. Following Klöckner and Blöbaum (2010), the latent variables of PBC and Social Norms were also included, and all 5 latent variables were allowed to co-vary, with 3 manifest variables per latent variable.

The CFA results indicated a good model fit;  $\chi^2(80) = 574.78$ ,  $p < .001$ , CFI = .92, RMSEA = .074 (90% .068 to 0.79), SRMR = .06, PCFI = .7. The highest reduction in error suggested by the modification indices (MI = 115.01) was for covariance between two of the Awareness of Consequences manifest variables<sup>13</sup> and were linked. Re-run of analysis was performed;  $\chi^2(79) = 429.89$ ,  $p < .001$ , CFI = .94, RMSEA = .062 (90% .057 to 0.68), SRMR = .05, PCFI = .71. At this point, modification indices suggested only minimal benefit (MI <40) and with no theoretical underpinning to support them, so the model was accepted.

Applying the NAM to model the data, the model fit was good;  $\chi^2(92) = 475.51$ ,  $p < .001$ , CFI = .94, RMSEA = .06 (90% .055 to 0.66), SRMR = .05, PCFI = .72. The structural model for the Full SEM for the NAM is shown in Figure 15.

<sup>13</sup> AC2 = “My travel mode contributes to climate protection” and AC3 = “My choice of travel mode has consequences for global ecological damage”





**Figure 15: SR Model pathways for the NAM, with standardised regression coefficients shown**

Detailed results for the SR SEM model analysis of the NAM are shown in Table 8:

**Table 8: Detailed results from SR analysis of the NAM**

Model Link	B	S.E	<i>p</i>	beta	Model Link	B	S.E	<i>p</i>	beta	R <sup>2</sup>
PEN → PEN1	1.00	-	-	.880	PEN → BEH	.066	.019	<.001	.105	.09
PEN → PEN2	.973	.027	<.001	.850	PBC → BEH	.232	.029	<.001	.281	
PEN → PEN3	.939	.026	<.001	.855	BEH					
AN → AN1	1.00	-	-	.853						
AN → AN2	.957	.034	<.001	.807	SN → PEN	-.015	.087	.863	-.007	.55
AN → AN3	.861	.034	<.001	.730	AN → PEN	.030	.085	.721	.030	
AC → AC1	1.00	-	-	.616	AC → PEN	1.009	.147	<.001	.721	
AC → AC2	.746	.065	<.001	.441	PBC → PEN	.016	.051	.758	.012	
AC → AC3	.599	.063	<.001	.355	PEN					
SN → SN1	1.00	-	-	.366						
SN → SN2	1.585	.156	<.001	.534						
SN → SN3	2.436	.274	<.001	.896						
PBC → PBC1	1.00	-	-	.615						
PBC → PBC2	.694	.072	<.001	.348						
PBC → PBC3	1.366	.107	<.001	.836						

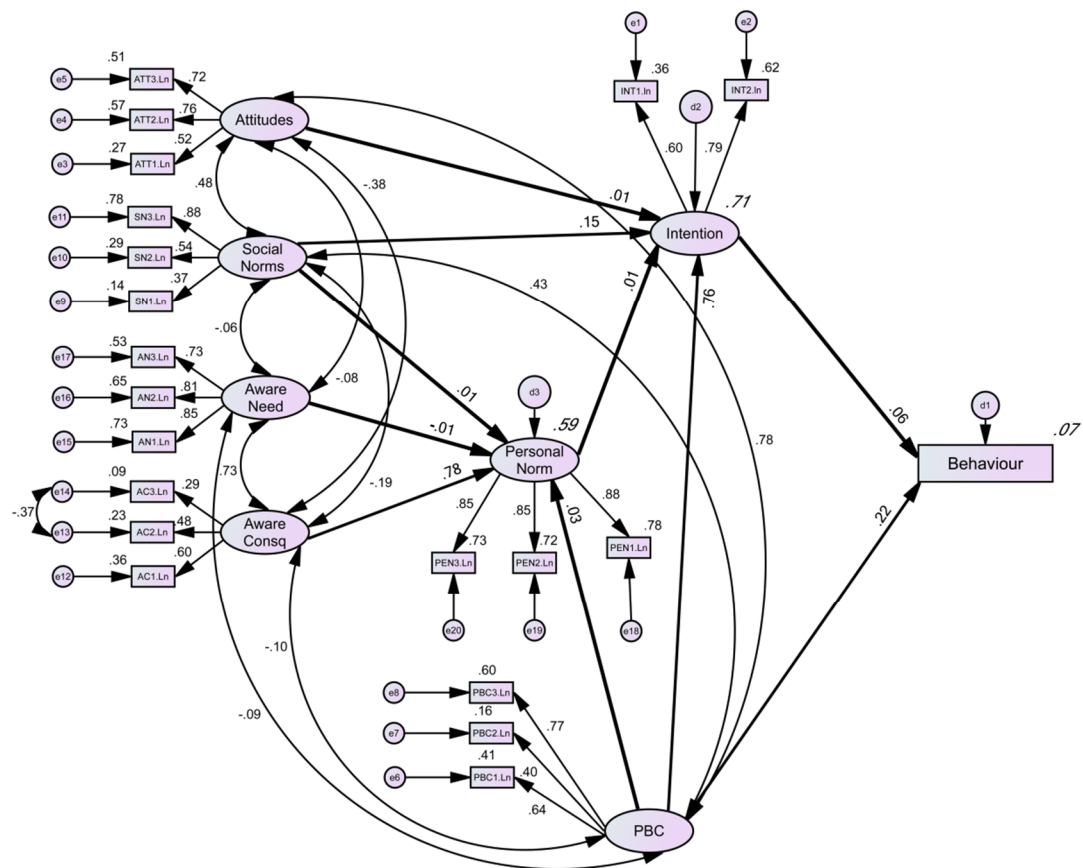
It appears that the SEM model was able to explain 55% of the variance in Personal Ecological Norm (PEN), and had a significant ability to predict Behaviour (BEH), though with only 9% of the variance explained.

### 5.4.3 Combining the Theory of Planned Behaviour and Norm-Activation Model

Combining the two models involves the 4 latent variables of the TPB (PBC, Attitudes, Social Norms and Intentions) and the 3 latent variables of the NAM (Personal Ecological Norm, Awareness of Need, and Awareness of Consequences). As before, a CFA model was constructed to measure the latent variables, and each variable allowed co-vary. The initial model fit was good;  $\chi^2$  (148) = 908,  $p$  <.001, CFI = .91, RMSEA = .067 (90% .063 to 0.71),

SRMR = .06, PCFI = .71. Observing the Modification Indices, a suggested link between AC2 and ATT3 (MI = 68.46) was noted, though this made little theoretical sense and was rejected.

Satisfied with the measurement model, I continued to develop the SR SEM model combining the TPB and NAM. The original CADM description by Klöckner and Blöbaum (2010) did not include Attitudes, though a more recent work places Attitudes as a predictor of Intentions, and allowed to covariate with other exogenous variables (Klöckner, 2013), and was applied here. The analysis found the model to fit;  $\chi^2 (169) = 1043.67, p < .001, CFI = .89, RMSEA = .067$  (90% .063 to 0.71), SRMR = .06, PCFI = .72. The strongest modification indices suggested several covariances of  $MI \leq 70$ , though none made theoretical sense and were ignored. The path display of the TPB and NAM combination model is shown in Figure 16.



**Figure 16: SR Model pathways for the combined TPB and NAM. , with standardised regression coefficients shown.**

Results of the combined TPB and NAM Structural Regression model are shown in Table 9.

**Table 9: Detailed results from SR analysis of combined TPB and NAM**

Model Link	B	S.E	<i>p</i>	beta	Model Link	B	S.E	<i>p</i>	beta	R <sup>2</sup>
PEN → PEN1	1.00	-	-	.882	INT → BEH	.054	.088	.608	.056	.07
PEN → PEN2	.772	.066	<.001	.849	PBC → BEH	.173	.072	.017	.219	
PEN → PEN3	1.211	.063	<.001	.854	BEH					
INT → INT1	1.00	-	-	.602						
INT → INT2	1.464	.088	<.001	.789	SN → INT	.206	.059	<.001	.147	.71
AN → AN1	1.00	-	-	.854	ATT → INT	.006	.084	.943	.006	
AN → AN2	.958	.034	<.001	.808	PBC → INT	.634	.080	<.001	.765	
AN → AN3	.859	.033	<.001	.729	PEN → INT	.004	.024	.880	.006	
AC → AC1	1.00	-	-	.602	INT					.59
AC → AC2	.838	.066	<.001	.483	SN → PEN	.022	.088	.805	.010	
AC → AC3	.504	.061	<.001	.292	AN → PEN	-.009	.071	.895	-.009	
ATT → ATT1	1.00	-	-	.516	AC → PEN	1.120	.126	<.001	.780	
ATT → ATT2	1.616	.104	<.001	.757	PBC → PEN	.032	.051	.530	.025	.59
ATT → ATT3	1.440	.095	<.001	.715	PEN					
SN → SN1	1.00	-	-	.374						
SN → SN2	1.574	.153	<.001	.483						
SN → SN3	2.346	.240	<.001	.881						
PBC → PBC1	1.00	-	-	.642						
PBC → PBC2	.772	.066	<.001	.404						
PBC → PBC3	1.211	.063	<.001	.773						

A novel aspect of the CADM is the integration of two established theories, and at this point, the model fit drops considerably, with CFI values below the recommended .95 and .90 limits, with RMSEA increasing. The results continue to show limited ability to explain variance in behaviour (7%), and which can be explained is solely from PBC. The variance of Intention explained by PBC and Social Norms is impressive (71%), though attitudes and PEN have no significant effect. The variance explained of PEN is also very good (59%) but again solely predicted by one latent variable: Awareness of Consequences.

#### 5.4.4 Constructing the Comprehensive Action Determination Model

Following the introductory steps proposed by Klöckner and Blöbaum (2010), the full CADM can now be modelled by introducing travel mode habit, and access to travel mode. The measurement model now includes habit with the 12 manifest variables, covariate with the previously measured latent variables. The first model run found an acceptable model fit;  $\chi^2$  (435) = 3025.87,  $p < .001$ , CFI = .83, RMSEA = .072 (90% .070 to 0.75), SRMR = .07, PCFI = .73.

Examining the modification indices, the strongest covariance edit (MI = 220.64) was between HB9 and HB6, both related to the perceived effort to not perform an action<sup>14</sup>, and were co-varied. Re-run analysis found an improved model fit;  $\chi^2$  (434) = 2783.66,  $p < .001$ , CFI = .84, RMSEA = .069 (90% .066 to 0.71), SRMR = .07, PCFI = .74.

The largest modification index (MI = 162.45) then suggested adding covariate between HB1 and HB7<sup>15</sup>, both items relating to frequency of behaviour, and were so linked.

<sup>14</sup> HB9 is “I would find hard not to do” and HB6 is “That would require effort not to do it”

<sup>15</sup> HB1 is “I do frequently” and HB7 is “That belongs to my (daily, weekly, monthly) routine”

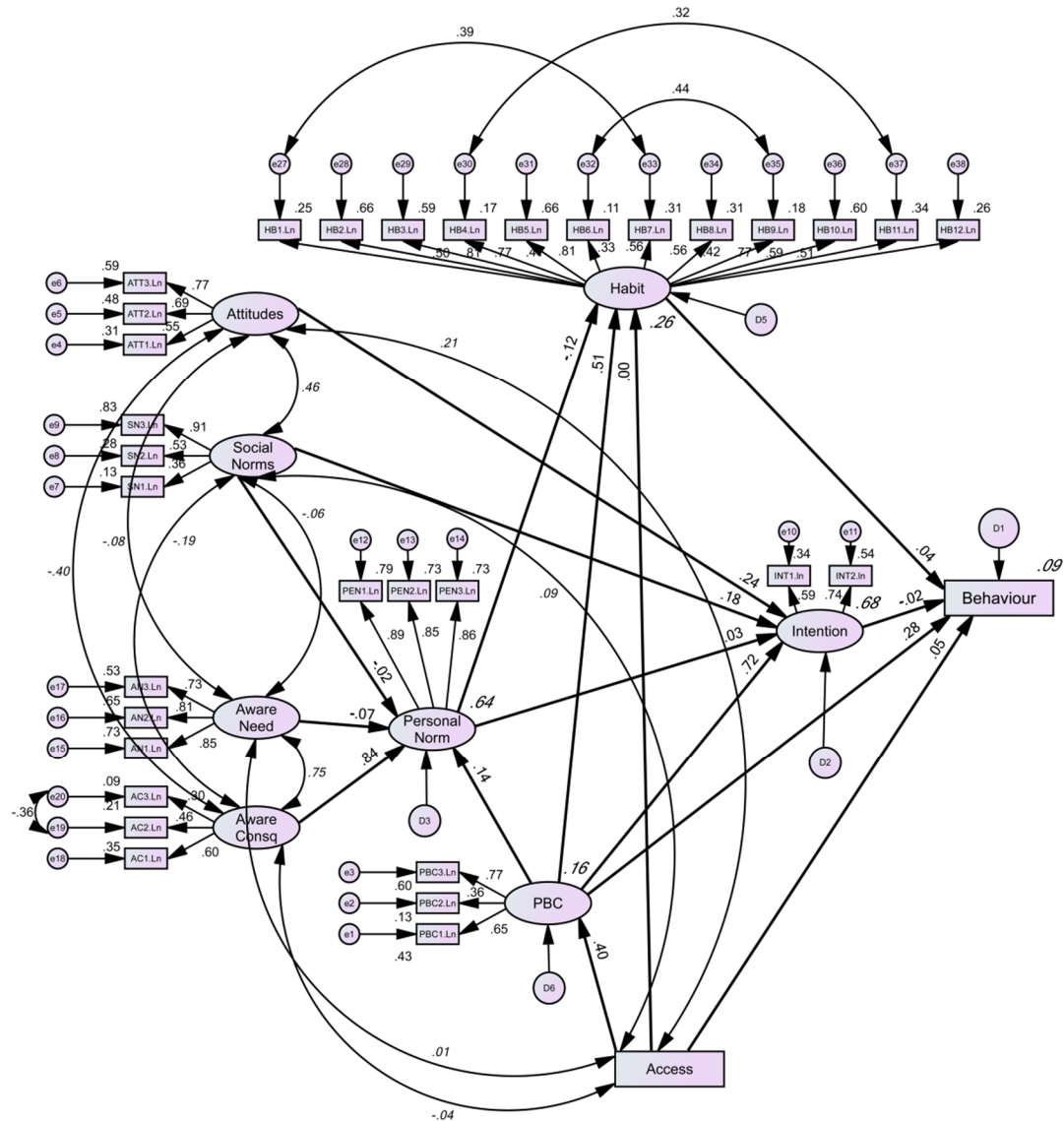
The edited model found further improvement;  $\chi^2 (433) = 2610.52$ ,  $p < .001$ , CFI = .86, RMSEA = .066 (90% .064 to 0.69), SRMR = .07, PCFI = .75.

Lastly, MI suggested covariance (MI = 103.05) between items for HB4 and HB11<sup>16</sup>, relating to the personal identity of the behaviour, which were co-varied. The model fit improved;  $\chi^2 (432) = 2502.73$ ,  $p < .001$ , CFI = .86, RMSEA = .065 (90% .062 to 0.67), SRMR = .07, PCFI = .75.

Though the CFI was less than optimal (<.95), other indices suggested acceptable model fit, so I attempted to run a full Structural Regression analysis for the CADM. A model solution was found;  $\chi^2 (499) = 3191.45$ ,  $p < .001$ , CFI = .82, RMSEA = .069 (90% .066 to .071), SRMR = .10, PCFI = .73, and the path diagram with standardised coefficients is shown in Figure 17 below.

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<sup>16</sup> HB4 is “That makes me feel weird if I don’t do it” and HB11 is “That’s typically ‘me’”



**Figure 17: SR Model pathways of the CADM, with standardised regression coefficients shown**

More detailed results are shown in Table 10:

**Table 10: Detailed results from SR analysis of the CADM**

Model Link	B	S.E	<i>p</i>	beta	Model Link	B	S.E	<i>p</i>	beta	R <sup>2</sup>
PEN → PEN1	1.00	-	-	.892	INT → BEH	-.020	.064	.752	-.020	.09
PEN → PEN2	.968	.026	<.001	.852	PBC → BEH	.216	.054	<.001	.278	
PEN → PEN3	.933	.025	<.001	.863	HAB → BEH	.050	.045	.272	.041	
INT → INT1	1.00	-	-	.586	MAC → BEH	.013	.009	1.471	.047	
INT → INT2	1.383	.093	<.001	.738	BEH					
AN → AN1	1.00	-	-	.853						.68
AN → AN2	.959	.034	<.001	.809	SN → INT	.250	.059	<.001	.183	
AN → AN3	.859	.033	<.001	.728	ATT → INT	.206	.041	<.001	.244	
AC → AC1	1.00	-	-	.595	PBC → INT	.549	.044	<.001	.715	
AC → AC2	.807	.065	<.001	.460	PEN → INT	.016	.022	.468	.026	
AC → AC3	.523	.062	<.001	.300	INT					.64
ATT → ATT1	1.00	-	-	.555	SN → PEN	-.050	.084	.555	-.022	
ATT → ATT2	1.369	.091	<.001	.690	AN → PEN	-.077	.083	.353	-.074	
ATT → ATT3	1.433	.093	<.001	.765	AC → PEN	1.240	.147	<.001	.838	
SN → SN1	1.00	-	-	.362	PBC → PEN	.182	.038	<.001	.144	
SN → SN2	1.581	.156	<.001	.526	PEN					
SN → SN3	2.500	.270	<.001	.909						

PBC → PBC1	1.00	-	-	.655					
PBC → PBC2	.665	.065	<.001	.355	PN → HAB	-.061	.016	<.001	-.123
PBC → PBC3	1.186	.066	<.000	.772	MAC → HAB	.000	.008	.983	-.001
HAB → HB1	1.00	-	-	.504	PBC → HAB	.322	.032	<.001	.508
HAB → HB2	2.162	.126	<.001	.812	HAB				.26
HAB → HB3	2.117	.127	<.000	.766					
HAB → HB4	1.055	.092	<.001	.412	MAC → PBC	.145	.013	<.001	.398
HAB → HB5	2.281	.133	<.000	.813	PBC				.16
HAB → HB6	.971	.102	<.001	.326					
HAB → HB7	1.276	.071	<.000	.555					
HAB → HB8	1.380	.098	<.001	.561					
HAB → HB9	1.215	.105	<.000	.420					
HAB → HB10	2.080	.124	<.001	.773					
HAB → HB11	1.495	.103	<.000	.587					
HAB → HB12	1.337	.101	<.001	.511					

Overall, the CADM replication explained 9% of variance in Behaviour, solely predicted by PBC, with other predictors non-significant. Habit was significantly predicted by Personal Norms and PBC, accounting for 26% of variance. Access to travel mode was a significant predictor of PBC, but not Habit or Behaviour.

#### 5.4.5 Comparing Travel Modes through the CADM

With an established CADM model, I wished to then compare how different travel mode users compared along the pathways. Though the applicability of the model to explain variance in travel mode choice was weak, it may be worth investigating how the models combined within the CADM compare among mode users. For example, Behaviour may have been better predicted for some mode user groups than others.

Multiple group comparisons in SEMs are an extremely complex area. Textbooks cover only one of two options in detail: comparing multiple groups on CFA models (Byrne, 2009) or comparing multiple groups on Path analysis models (Blunch, 2008; Kline, 2005; Schumacker & Lomax, 2010). In addition, the available textbook guides only cover comparisons of two groups (e.g. Gender), and address >2 group comparisons as possible, but with little discussion on the method. With a Structural Regression model, and 4 different groups, the current scenario has only limited amount of guidance. To address this problem, the method of assessing multiple group differences will be briefly discussed, before outlining my rationale for the selected method.

One difficulty with comparing groups for structural regression SEM methods is the uncertainty over the preferred method; some applications are possible but require equal sample sizes (Evermann, 2010). Another method tests if parameters between models are of equal strength by comparing covariances matrices, though again this technique is hampered by over-reliance on sample sizes being large and equally sized (Blunch, 2008). The multi-group method detailed by Byrne (2009) is to compare groups by placing constraints on the models to be equal across groups, evaluating the model fit, and considering whether relaxing constraints to vary across groups will present a better fit. If relaxing a constraint (allowing it

to vary to best suit the group considered) produces a statistically better fit, then the groups can be said to be significantly different. Using Amos software allows this last approach of defining appropriate groups, and comparing model for each group with increasing constraints upon model characteristics.

My primary interest in this research was how users of different modes may differ in their pathways between latent variables: e.g., whether behaviour was more successfully predicted by habit for cyclists than for bus users. The guides on group differences for CFA often assume that the question focuses on the applicability of a scale across different cultures or genders (Byrne, 2009). Comparing groups for CFA is based upon similar answers to questions between groups, and first constrains error covariances for questions first, then containing other variance/covariances. While a useful endeavour for calibrating measures, my concern was the predictive utility between variables. When considering multi-group analyses for SR-SEM models with latent variables (as with the current analysis) Blunch (2008) instead advises considering the regression weights first (p.215), with other matters as secondary concerns. The emphasis on regression weights suits my research question, and was followed here. The four groups from my data (bicyclists, car drivers, bus users, and walkers) were programmed into Amos, and separate models of increasing constraints were specified and run. The comparison of model fit, based on the increasing level of constraints applied, is summarised in Table 11.

**Table 11: SR Model multiple group comparisons of travel mode groups, with structural regression weights included first**

Model	CMIN ( $\chi^2$ )	df	<i>p</i>	CFI
Unconstrained	4241.37	1996	<.001	.844
Structural Weights	4352.46	2035	<.001	.839
Structural Covariances	5099.75	2080	<.001	.791
Structural Residuals	5116.63	2092	<.001	.790
Measurement Residuals	5730.34	2203	<.001	.756

Byrne (2009) advises using two metrics to compare the fit of comparative groups on the model;  $\chi^2$  (the more traditional statistic) and the CFI (more recently used). In Table 11, the “Unconstrained” model is where all parameters are estimated for each group simultaneously; there are no constraints on values between groups and this model is the baseline against all other constrained models. The second model (Structural Weights) fixes all regression coefficients from/to latent variables as the same, and re-evaluates model fit. The  $\chi^2$  value represents a difference of 111.09 with 39 added degrees of freedom, the 39 degrees reflecting the total 13 regression coefficients towards latent variables for the 3 groups ( $13 \times 3$ ) that were constrained to the values of the first group (bicyclists). The difference between these two models was statistically significant at  $p < .001$ , based on a test for  $p < .05$ , suggesting that some regression coefficients are significantly different across the 4 groups. The  $\chi^2$  approach

however can provide markedly different results to the alternative, CFI approach (Byrne, 2009). By examining the change in CFI values across each constrained model, we see the model fit decrease markedly with increasing constraints. The guideline for change in the CFI (or  $\Delta\text{CFI}$ ) is .010 (Cheung & Rensvold, 2002), and the  $\Delta\text{CFI}$  is .005 for the first constraint model.

Reviewing the results from Table 11, we see that the primary constraint of assuming equal regression coefficient weights, across the 4 groups, shows a significant decrease in model fit using the  $\chi^2$  statistic. However, the CFI result of  $<.010$  more strongly suggests that the constraint has only a limited effect on model fit, and so the regression-paths may be seen as non-significantly different. The data therefore do not support the hypothesis that travel mode user groups differ within the CADM. The constrain of Structural Covariances suggests that the groups differ in their covariances between variables, but not the predictive link between variables. Additionally, relaxing constraining residual errors (structural and measurement) shows differences between groups, but this is often seen as excessive in modern analyses: they are often omitted for being overly restrictive (Byrne, 2009) and included here as a formality.

#### 5.4.6 Multiple Regression Check for Predicting Intention

The non-significant link between Intention and behaviour led to suspicions of the behaviour measure, especially since Intention was highly explained with only weak links to behaviour. As a check, multiple regression analysis was performed to predict behaviour from the combined score for each latent variable: e.g., habit was averaged out of the 12 predictor variables into one score. Using Forward Stepwise regression, the best predictors of behaviour were evaluated, free of theoretical constraints, as a check on the best possible scenario to predict behaviour, with results shown in Table 12.

**Table 12: Results of "Ideal world" Stepwise Regression predicting Behaviour from Latent Variables free of theoretical constraints**

	B	S.E.	Beta	t	p	95% CI
<i>Step 1</i>						
Intention	0.14	0.02	0.22	7.61	<.001	[0.10, 0.18]
Constant	0.46	0.03		16.31	<.001	[0.40, 0.52]
<i>Step 2</i>						
Intention	0.10	0.02	0.16	5.09	<.001	[0.06, 0.14]
Habit	0.10	0.02	0.14	4.35	<.001	[0.06, 0.15]
Constant	0.40	0.03		13.19	<.001	[0.34, 0.47]
<i>Step 3</i>						
Intention	0.09	0.02	0.14	4.52	<.001	[0.05, 0.13]
Habit	0.09	0.02	0.12	3.89	<.001	[0.05, 0.14]
Access	0.03	0.01	0.10	3.39	0.001	[0.01, 0.05]
Constant	0.25	0.06		4.36	<.001	[0.14, 0.36]
<i>Step 4</i>						



Intention	0.09	0.02	0.14	4.53	<.001	[0.05, 0.13]
Habit	0.10	0.02	0.13	4.20	<.001	[0.05, 0.14]
Access	0.03	0.01	0.10	3.30	0.001	[0.01, 0.04]
PEN	0.06	0.02	0.09	3.27	0.001	[0.02, 0.09]
Constant	0.18	0.06		2.93	0.003	[0.06, 0.29]

A stepwise multiple regression indicated 4 significant predictors of Behaviour: Intention, Habit, Access to Mode and Personal Ecological Norm, with a combined  $R^2$  of .082: a smaller amount of variance explained than the full CADM, which explained 9% of variance.

## 5.5 Discussion

This chapter details a replication of the Comprehensive Action Determination Model (CADM: Klöckner & Blöbaum, 2010). The CADM combines the Theory of Planned Behaviour (Ajzen, 1985, 1991), the Norm Activation Model (Schwartz, 1977; Schwartz & Howard, 1981), habitual processes, and situational context into a single explanatory model. Using a similar methodology of questions and analysis properties as the original publication, the eventual model has a mixture of similarities and discrepancies with the CADM, but several complications emerged through the analysis. Though the CADM model solution was achieved, the model was a poor fit of the data, with uncertain results when predicting behaviour, and several methodological issues arose that question the validity of the CADM.

### 5.5.1 Complications with using Structural Equation Modelling

Before discussing results in detail, I must note that the difficulty of Structural Equation Modelling (SEM) makes the results more confusing. The difficulty of SEM has been noted by researchers (Schumacker & Lomax, 2010; Ullman, 2013), especially since the field has seemingly little cohesion in the correct methods. With the caveat that even describing SEM is difficult, I can now consider the difficulty in interpreting the results.

Firstly, the CADM was successfully identified using SEM, though the final model fit was questionable; the  $\chi^2$ , CFI, and SRMR indices suggest the model had some problems when applied to the data, whereas RMSEA and PCFI values are more supportive of the model. The confusion of separate indices was described in the introduction of SEM, and reflects methodological uncertainty in SEM research. It is interesting that aside from the troubled (but traditional)  $\chi^2$  measure that is consistently inflated by sample size (Ullman, 2013), the two absolute fit indices conflict: RMSEA results suggest an acceptable fit, while SRMR suggests an unacceptable fit. As one of the most popular indices (Byrne, 2009; Ullman, 2013), the CFI result deserves consideration, with results suggesting a model fit that borders on problematic. Comparative fit indices give a value for the model based on a continuum between two extremes; the *Saturated Model* with a  $\chi^2$  of 0,  $df = 0$ , which is a perfect fit of the data (so the model is a perfect fit of the data, and would be just identified), and the *Independence Model*

which has no paths between variables and has the maximum possible  $\chi^2$  value, where the df is the number of observations minus the number of parameters estimated (Schumacker & Lomax, 2010). As may be expected with the vast array of indices available, each indice has been critiqued: comparative fit indices have been criticised for the working assumption of the independence model, with zero covariances between variables, which is an extremely implausible scenario and results may therefore be too conservative (Blunch, 2008; Kline, 2005). Curiously, when comparing the CFI with the parsimony-corrected PCFI value, which should be more conservative (Byrne, 2009), the PCFI offers a more optimistic evaluation of model fit. Ultimately, several indices are suggested because of the complexity of the model evaluation (Blunch, 2008; Schumacker & Lomax, 2010), and the fact that cut-off values can be arbitrary, and treated as gospel truths when indices measure the model against the data, but not the theory (Hayduk, Cummings, Boadu, Pazderka-Robinson, & Boulianne, 2007). Some researchers have taken considerable liberties when evaluating indices; Liping, Yuqing, Yuntao, and Yishan (2009) published an RMSEA value of .159 after specifying the desirable value of <.06, and still refer to their model as “acceptable” (p. 308). Nonetheless, the practice of reporting multiple indices illustrates the complexity of the technique, and the current results suggest that the current CADM output has no extreme violations of index guidelines, and may be interpreted, but with some degree of caution. It should be noted that the original CADM publication (Klößner & Blöbaum, 2010, p.580) reported an excellent model fit;  $\chi^2$  (151) = 210.16,  $p < .001$ , CFI = .99, RMSEA = .03, SRMR = .03.

### **5.5.2 Challenging the Comprehensive Action Determination Model method**

Considering the excellent model fit by Klößner and Blöbaum (2010), and the less-excellent model fit for my current results, there are several possible explanations. Klößner and Blöbaum (2010, p. 579) specify that they did not use any “post-hoc model modifications”, whereas I used modification indices (though strictly adhering to theoretical basis). They do mention, however, that prior to their data collection, pilot testing was used to establish the best possible questions using Cronbach’s alpha, and “the best two or three items per latent variable were selected based on the pre-test data” (p. 579). It is unclear exactly how Klößner and Blöbaum (2010) chose their questions: what the Cronbach’s alpha limit was, why either 2 or 3 questions, or their exact justification for choosing them. By hand-selecting questions with high inter-reliability, although they refrain from post-hoc modifications, they ensured their questions were highly correlated with less unexplained variance between them. In the case of latent variables then, with high inter-correlation the latent variable would explain more variation, and thus produce a better model fit. As a direct replication I sought to use their questions, and though applying modification indices where appropriate is widely accepted (Blunch, 2008; Byrne, 2009; Cole et al., 2007; Schumacker & Lomax, 2010) using pre-

determined measures of high correlation will also improve model fit (Schumacker & Lomax, 2010), which may explain the reduced model fit found in this replication.

Klößner's choice of 2 or 3 predictors per latent variable is also interesting, as guidelines for SEM often require more. Schumacker and Lomax (2010) advise 3 or 4 items, Blunch (2008) sternly advises at least 4, and Kline (2005) cites Kenny's (1979) rule of thumb as "Two *might* be fine, three is better, four is best, and anything more is gravy" (p.143, emphasis in original). By most definitions, the use of 2 or 3 indicator variables is weak and further variables are needed: especially since not all indicator variables may be useful and pass the measurement model testing (Blunch, 2008). As a replication of the CADM I wanted to copy the method used by Klößner and Blöbaum (2010), though I would now suggest that any future replications increase the number of questions for indicator variables. Increasing the use of indicator variables is useful since latent variables can be multi-faceted, and require variation in measurement (Schumacker & Lomax, 2010). But within SEM, there is a trade-off for the number of items used to predict latent variables. Through Monte Carlo simulations, increasing the number of indicators produced more accurate results for path coefficients, though ironically at the expense of reduced Goodness-of-fit indices (Ding, Velicer, & Harlow, 1995; Marsh, Hau, Balla, & Grayson, 1998). In effect, there is a discrepancy between model accuracy and model fit. As mentioned by Kline (2005), over-reliance on model fit indices may miss the most important parts of SEM, that is, the actual links between variables, so the CADM should use greater numbers of indicators for more accurate estimations of pathways. The use of 2 or 3 predictors by Klößner and Blöbaum (2010) may not be incorrect, but could be an oversimplification that increases model fit, while not accurately representing actual links between variables: this may also explain the good model fit found in the original CADM that has not been replicated here.

### **5.5.3 Measurement complications may have disrupted the Intention-Behaviour link**

Speaking of links between variables, we can now consider how the current analysis and the original CADM report compare. Throughout each stage of my analysis, emulating the steps in the original CADM discussion, the predictive link to behaviour remained consistently low at 7% variance explained by the TPB and the combined TPB/NAM model, and peaking at 9% by the NAM and the CADM. This disparity of predictors and actual behaviour was tested using an exploratory stepwise multiple regression to predict behaviour from any latent variable (free of theoretical constraints). This 'context-free' analysis still found that only 8% could be explained, and supported the use of Intention, Habit, and Access to Mode as key predictors. Personal Ecological Norm also became a minor predictor, though PBC (the only significant predictor in my CADM result) was not included; despite significant links during the stepwise regression, alternate predictors had stronger links, demonstrating the value of

SR-SEM models to model complex links that may be missed in standard multiple regression. The fact that even this ‘best-case’ scenario failed to find a substantial link to behaviour strongly suggests that the measurement of behaviour within this study was flawed.

Behaviour was measured as a retrospective 7-day travel diary: the total number of trips taken by participant’s specified main mode (e.g. bicycle) was divided by the total number of trips taken that week for a ratio of mode choice. Travel diaries have been found to be generally reliable, having been linked to GPS-tracked behaviour (Bricka, Sen, Paleti, & Bhat, 2012), and the behaviour ratio measure employed was successfully used by Klöckner and Blöbaum (2010), and Klöckner and Matthies (2009). Though the previous applications recorded daily behaviour after the survey, and using retrospective behaviour as a dependent variable for future intention has been suggested as a flawed concept (Abrahamse, Steg, Gifford, & Vlek, 2009; Steg & Nordlund, 2012) which may have reduced the relationship between intentions and behaviour, other researchers have successfully modelled pathways based on retrospective behaviour (Harland et al., 1999; Heath & Gifford, 2002).

A possible solution may be due to the specificity of previous studies and the more generic-style questions used. Without the availability of ‘piping’ in the survey tool used (using previous responses to make questions more specific), it was only possible to use generic questions. For example, one Intention measure read: “I have a strong intention to use my main travel mode for regular trips”, but wasn’t specific to the person’s main mode (e.g. “strong intention to walk for regular trips”) as in previous work (e.g. Klöckner & Blöbaum, 2010). More specific questions have better predictive ability for behaviour, and the use of generic terms may have clouded this. This is what Ajzen and Fishbein (1977) call the “Principle of Compatibility” – the link between attitudes and behaviour exists only when measures are specific to the behaviour in question. In my attempt to model different travel mode groups, without the ability to make questions specific, questions were not exact enough and this could explain the disparity in predicting behaviour.

Fortunately, the Principle of Compatibility complies with the rest of the TPB, NAM, and Habit questions, as they were consistent in their approach of general questions about “main mode”, and associations between items of similar generalisation are still valid (Ajzen, 1988). This suggests I can compare the path coefficients from the current analysis with Klöckner and Blöbaum (2010) and other CADM reports, especially as a number of latent variables have a high degree of variance explained. In the final model, 68% of variance in Intention was successfully explained by the TPB components (Attitudes, Social Norms and PBC), and 64% of Personal Ecological Norm (PEN) was explained.

The case of the NAM is interesting as only one NAM-specific construct (Awareness of Consequences) was significantly linked to PEN: Awareness of Need (AN) and Social Norms

were both non-significant. There is an extremely high co-variation (.75) between AN and Awareness of Consequence (AC), which means that AC may have controlled for any influence from AN. A brief check of the CADM by removing AC shows that AN was a significant predictor of PEN (Beta = .55,  $p < .001$ ), and likely shares a large amount of variance that is taken by AC in the full CADM. The similarity between the two variables was also noted by Klöckner and Blöbaum (2010), who suggested AN questions use more general terms to avoid similarities with AC questions, which were more specific. However, my current analysis included a separation; AN questions were based upon general links between transport and emissions, and AC questions focused on personal contributions through a person's own travel mode. With the large similarities between the two variables recognised, further attempts to separate these factors may be needed in future research.

For the TPB constructs, the links are as expected with a large amount of variance for Intention predicted (68%) by the three antecedents in descending order of strength; Perceived Behavioural Control (PBC), Attitudes, and Social Norms. This pattern of results observed in a previous meta-analyses of TPB reports (Armitage & Conner, 2001) and in the recent Meta-analytical SEM of the CADM (Klöckner, 2013) lending support to the current findings.

#### **5.5.4 Apparent inconsistencies within CADM specifications**

The CADM combines three key theories in the field which have all been replicated and validated across various samples. The key contribution of the CADM is the way they are inter-connected. The combination of the TPB and NAM has been previously suggested a number of times (Bamberg, Hunecke, & Blöbaum, 2007; Wall, Devine-Wright, & Mill, 2007), and the use of Habit within travel mode choice is a familiar point (Aarts, Verplanken, & van Knippenberg, 1997), suggested to be included alongside the TPB (Conner & Armitage, 1998; Gardner & Abraham, 2008), as well as combining habit with the NAM (Klöckner & Matthies, 2004). The unique additions of the CADM is how all these concepts interlink: predicting Habit using PEN, PBC and Access to Mode, predicting Intention from PEN, and predicting PEN by PBC. The theorised links proposed in the CADM, however, appear to be inconsistent across the five published reports that have used the model: the original publication of the CADM (Klöckner & Blöbaum, 2010), studying recycling behaviour (Klöckner & Oppedal, 2011), travel mode choice (Klöckner & Oppedal, 2011), installing a new heating system (Sopha & Klöckner, 2011), and a Meta Analytical Structural Equation Model (MASEM) analysis of several environmental behaviours (Klöckner, 2013).

When discussing the inclusion of predicting Habit strength by PEN and PBC, in the original report, Klöckner and Blöbaum (2010) state that personal norms “*influence habits due to their high temporal stability*” (p. 576). The recent MASEM analysis however states that “*habit strength is theoretically not related to the other model variables*” (Klöckner, 2013, p.

4), though still predicts habit from PBC, PEN and Intention. The link between intention and habit is unclear within the CADM. Originally, Klöckner and Blöbaum (2010) suggest that habit is predicted by “*constructs which demonstrate long-term stability*”, such as personal norms, and excludes intentions “*which are generated in the decision making situation*” and temporary (p. 577). Yet habits are predicted by Intentions in a later application of the CADM for recycling (Klöckner & Friedrichsmeier, 2011) without clear explanation, and also in the MASEM of general pro-environmental behaviours (Klöckner, 2013). One publication of the CADM treats Habit as an exogenous variable without any predictors, but also attempts to apply habit to a one-time decision of installing a new household heating system (Sopha & Klöckner, 2011): a behaviour unlikely to be influenced by routines.

When considering Attitudes, a similar picture emerges. The original report did not include a measure of Attitudes (Klöckner & Blöbaum, 2010), but a study of wood-pellet stove purchases by Sopha and Klöckner (2011) predicts Attitudes from PEN and PBC, and later the MASEM analysis by Klöckner (2013) changes the NAM to the Value-Belief Norm Theory whilst no longer predicting Attitudes from any other variables. The MASEM paper has no theorised link predicting attitude, but in the method section, a covariance modification indice is included between PEN and Attitudes to improve the model fit (Klöckner, 2013, p. 1034). But it’s not clear why Attitudes are not directly predicted from PEN, instead of using a post-hoc modification indice, since it was previously argued that “personal norms should over time influence also attitudes, because they act as a moral reference system in the background of decision making that single beliefs might be checked against” (Sopha & Klöckner, 2011, p. 2758). In addition, Personal Norms are not predicted by PBC in only two of the five published reports (Klöckner & Oppedal, 2011; Sopha & Klöckner, 2011).

When introducing SEM methodology earlier in this chapter, the first step of the research process is described, where the researcher specifies the variables to be included and how they interact (Model Specification). This is seen as the most difficult part of SEM, as it defines the model to test against reality (Schumacker & Lomax, 2010). With five different models proposed, without consistent application of theory, I cannot help but be suspicious that the CADM Model Specification is flawed. At no point does Klöckner address the differences between model specifications, or attempt to describe the change of models as evolutions that benefit from changes in specification. The CADM uses three well-established models, but their interaction (the original contribution) is unspecified. The validity and predictive power of the three theories are documented in previous work: the TPB and Habit are known to be good predictors of intention and behaviour (Gardner & Abraham, 2008), and the NAM has also shown strong links across several behaviours (Bamberg & Möser, 2007). The three established components are thus the likely reason for good model fit when initially

evaluating the models in separation, and may explain why the application of proposed CADM links between these models led to a decrease in model fit.

Instead, the CADM could be improved by re-specification, particularly for the influence of rational choice models (TPB and NAM), as well as automatic process of habit, in a more considered way. The CADM presents habit as a direct force on behaviour alongside intention and situational constraints. Habitual behaviours develop over time and originally began as intentions, before developing into automatic reactions to achieve a goal in a stable environment (Wood & Neal, 2007), and strong habits can overcome or mitigate the influence of intentions on behaviour (Gardner, 2009; Verplanken, Walker, Davis, & Jurasek, 2008). But habitual influences extend beyond behaviour, and influence how people use travel information (Aarts et al., 1997; Verplanken, Aarts, & Van Knippenberg, 1997) and influence attitudes toward travel modes (Pedersen, Friman, & Kristensson, 2011a, 2011b). Habitual influences across the range of rational choice concepts is not included within the CADM, and the temporal nature of habits that occur from perception, attitude formation, and behaviour, are unaccounted for. Although Klöckner (2013) notes the difficulty in applying habit in a static analysis of influences, other researchers have previously been able to model the various effects of habit on the TPB in a more naturalistic way. Examining fruit-eating behaviour, de Bruijn et al. (2007) established three groups of low, moderate, and high strength habit and compared SEM Path Analysis for the three groups, identifying the moderating effect of habit on intention. Alternatively, recent work on dual-process models of cognition have begun to explore the interaction between automatic processes (such as habit) and reflective processes (such as the TPB) which might offer possible methods of combining these processes: the Hybrid Model proposed by Evans (2009) considers conflict resolution between the two processes, or the Tri-Process model proposed by Stanovich (2011) that weighs the amount of mental simulation of outcomes to determine behaviour. To fully explore the role of automatic and reasoned influences within one framework may be possible, but future work is needed to identify an appropriate model that can successfully combine the two influences.

## **5.6 Conclusions**

The replication of the CADM highlighted a number of difficulties and problems. By attempting to apply the model to a range of groups without specifying precise questions, items may have violated the Principle of Compatibility which led to poor predictions of behaviour. Future work will aim to ensure that the prediction of specific behaviour is matched by specific questions. Secondly, the field of Structural Equation Modelling is characterised by a confusion of methods, terms and principles, and requires a number of subjective decisions that threaten to comprise the validity of results, making interpretation difficult. Despite these issues, the clearest result from a careful analysis of the CADM is that the model is not

reliable. Although combining three established theories generates a high degree of variance explained in psychological constructs, the novel aspects of the CADM are inconsistently applied, interpreted, and may also use too few predictors to accurately model decision making. There may be opportunity to expand the CADM using some conflict between automatic and reflective concepts, though future research should establish representation of the model, with theoretical considerations described prior to analysis, and ensure accurate and detailed methods of collecting data from participants.





## **Chapter 6: Development and validation of an implicit measure of environmental preferences**

*“So although it may be more desirable to have a green future . . . to simply say “40% carbon reduction” . . . I don’t agree with that”*

**- Sean, Car Driver (11-14)**

### **6.1 Abstract**

*With contrasting views on environmental preferences in focus group responses (Chapter 3), and a lack of differences in survey results (Chapter 4), an alternative method to measure environmental preferences was sought. Considering the possibility that explicit measures may be open to self-presentation bias to enhance appearance of being ‘green’, implicit methods may overcome such barriers; however current approaches may have methodological flaws. Therefore, a new implicit approach to environmental preferences was designed. Taking inspiration from work on environmental values, a set of balanced and representative stimuli were developed to contrast implicit preferences toward egoistic and biospheric value orientations using the Implicit Association Task (IAT: Greenwald et al., 1998). Across three independent samples (total  $n = 293$ ), this Environment IAT (1) showed expected positive correlations with explicit measures of environmental values and attitudes, (2) reflected significant differences between environmentalists and non-environmentalists, and (3) was a unique predictor of environmentalist status even after controlling for explicit values and attitudes. Despite the success of the measure, no explicit or implicit differences between active and non-active travel mode users were found. This suggests any differences reported in the Chapter 3 focus groups are likely minimal or selective representations of the general groups.*

### **6.2 Introduction**

A surprising finding from the focus groups (Chapter 3) was the varied opinions toward environmental issues. Car and motorcycle users discussed several statements of support for environmental protection, but critiqued any measures or targets to address these issues. Active travel mode users (bicyclists and walkers) also gave strong support to environmental causes, but then praised environmental protection policies (saving their own critique for inaction). In light of these findings, I attempted to explore differences in travel mode user groups using the 2010/11 Travel Survey (Chapter 4). Results, broken down by travel mode choice, indicated no substantial differences in environmental worldviews (measured by the New Ecological Paradigm; Dunlap et al. 2000) between user groups. This raised the possibility that

expressions of environmental preferences may appear in some forms (open discussion) but not in others (explicit surveys). I wanted to research this idea in more detail, as it may help to predict travel mode choice, and could be used in the promotion of sustainable travel modes.

Firstly, I need to consider how environmental preferences are currently measured. The concept of measuring environmental preferences is difficult; a field described across three decades of research as “hopelessly disorganised” (Heberlein, 1981, p. 242), “anarchy” (Stern, 1992, p. 279), and “daunting” (Dunlap & Jones, 2002, p. 483). The complication arises from both sides of the question; preferences are a hypothetical construct that are difficult to universally define, and environmental issues are multi-faceted constructs of various factors (Heberlein, 1981). Noting the difficulty of the task, Dunlap and Jones (2002) offered a comprehensive review of environmental concern that evaluated “at least 700-800” (p. 493) published measures of environmental concern, and expanded upon the complexity suggested by Heberlein (1981). Their review found definitions of ‘the environment’ varied greatly across three broad areas: specificity of issues (e.g., ranging from general pollution to individual cases), scale of the problem (e.g., ranging from national to household effects), and time period of problem (e.g., current or previous events). (Dunlap & Jones, 2002). In addition, the definition of ‘concern’ was separated into three areas that can define a person’s assessment: cognitive evaluation of a topic, the emotive or affective links to a topic, and behavioural intentions linked to a topic (Zanna & Rempel, 1988). Grouping these factors together, Dunlap and Jones (2002) suggested four broad domains of environmental preference<sup>17</sup> measurement:

1. *Multiple Topic, Multiple Expression*: scales and measures that cover a mix of attitude constructs across a range of environmental issues
2. *Multiple Topic, Single Expression*: tools that focus on a particular attitude construct (e.g., cognition or affect) across a range of environmental issues
3. *Single Topic, Multiple Expression*: measurement of several attitude constructs to a particular environmental issue (e.g., deforestation or carbon emissions)
4. *Single Topic, Single Expression*: a specific measure of one attitude construct towards a particular environmental issue

From the vast array of measures described by Dunlap and Jones (2002), three multiple topic, multiple expression measures grew to dominate the field (Dunlap & Jones, 2003): Maloney, Ward, and Braucht’s (1975) “Measurement of Ecological Attitudes and Knowledge”, Weigel

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<sup>17</sup> With a confusion of terms, this chapter will use “environmental preferences” as a general placeholder when referring to a person’s consideration of environmental issues, with explicit mention of concepts such as attitudes and values where appropriate.

and Weigel's (1978) "Environmental Concern Scale", and Dunlap and Van Liere's (1978) "New Environmental Paradigm". All three measures have shown good validity and reliability (Dunlap & Jones, 2003), though one scale emerged as the most popular: The New Environmental Paradigm.

Concerned with society's views that increasingly promoted economic success and materialism, Dunlap and Van Liere (1978) sought an alternative view that challenged, what they termed, the Dominant Social Paradigm (DSP), sometimes known as the Human Exceptionalism Paradigm (HEP; Catton Jr & Dunlap, 1978). Conceptualising several aspects of the DSP, Dunlap and Van Liere (1978) designed 12 questions that challenged DSP facets to create and promote the New Environmental Paradigm, measuring attitudes on ecological limits to growth, maintaining the balance of nature, and renouncing human exceptionalism upon nature. Revised two decades later, Dunlap, Van Liere, Mertig, and Jones (2000) published the New Ecological Paradigm (NEP). The NEP featured a more modern terminology, and was extended to 15 questions that now included items measuring belief in an eco-crisis and the conflict between ecological concerns and industrial growth (Dunlap et al., 2000). Since the first publication in 1978, the old and revised scales have become the most popular measures of environmental worldviews, with supporting evidence of validity and applicability across several cultures (Dunlap, 2008; Hawcroft & Milfont, 2010).

However, applying the NEP (Dunlap et al., 2000) in Chapter 4, despite clear differences in Chapter 3 discussions, found no substantial differences between travel mode user groups. Given the contrasting results using different methods, potentially, there is variation in views that the NEP does not capture. Using an explicit survey approach, the NEP may facilitate a stronger preference for the environment by providing salient information: a known effect when considering the environment (Durfee, 2006; Joireman, Barnes Truelove, & Duell, 2010; Viscusi & Zeckhauser, 2006). In addition, several authors have raised concerns that measuring environmental preferences may be open to social desirability biases (Beattie & Sale, 2009; Ewert & Galloway, 2009; Fischer, Peters, Vávra, Neebe, & Megyesi, 2011; Oerke & Bogner, 2011). Social desirability biases can be demonstrated in two ways: self-deceptive positivity that distorts a person's self-presentation, or impression management to other people (Paulhus, 1991). False representations of concern for the environment were described within the Focus Groups as 'Greenwashing', and examples of Greenwashing exist in adverts for food, household goods, services, media, car adverts, and more (Pearse, 2012). For self-reported environmental views, it remains unclear whether biases can be characterised as self-deceptive positivity; people seen by Fischer et al. (2011) as "fallible, but ultimately well-meaning" (p. 1029), or bias through impression management: people described by Beattie and Sale (2009) as "green fakers". Given the recognition of greenwashing, the

potential for self-presentation bias, and that available information may influence self-reported environmental concern, I sought an alternative measure that may avoid these issues – implicit measures of preferences.

### **6.2.1 Implicit Measures and Environmental Concern**

To begin with a broad definition of an implicit measure, De Houwer, Teige-Mocigemba, Spruyt, and Moors (2009) suggest that the defining characteristic of implicit measures is that they capture automatic assessments, rather than consciously-reasoned assessments. The distinction between implicit and explicit preferences can be framed from dual-process views that contrast automatic (Type 1) and reflective (Type 2) processes; people can explicitly state their preferences such as through a survey (Type 2), which may be separate from their implicit and automatic (Type 1) preferences (Smith & Collins, 2009). Implicit measures of preferences typically employ computerised tasks that measure the speed (normally in milliseconds) a person associates two stimuli, and inferring from this an implicit measure of association through the speed of connections (Teige-Mocigemba, Klauer, & Sherman, 2010). For example, if a person were quicker at associating stimuli representing ‘good’ with stimuli representing ‘flowers’, and slower when pairing flowers with ‘bad’ stimuli, we may infer a positive implicit preference for flowers (Greenwald, McGhee, & Schwartz, 1998). Implicit measures are flexible, and can be applied to a range of topics that includes intergroup relations, item satisfaction, personality characteristics, and clinical diagnoses (Greenwald, Poehlman, Uhlman, & Banaji, 2009). Implicit measures of preferences can be preferable to conventional approaches, since they can avoid several complications of explicit measures (Teige-Mocigemba et al., 2010), including limited ability for introspection without external cues (Nisbett & Wilson, 1977; Nosek, Greenwald, & Banaji, 2007), and aforementioned influences of social desirability bias (Greenwald et al., 2009; Paulhus, 1991).

In contrast to the range and popularity of explicit environmental measures, such as the NEP (Dunlap et al., 2000), there are very few implicit measures linked to the environment. One implicit measure proposed by Beattie and Sale (2009) compared positive/negative preferences towards products that had relative low carbon footprints (e.g., modern fluorescent light bulbs) against high carbon footprints (e.g., older incandescent light bulbs) as a proxy for environmental concern. This approach, however, is reliant on the participant’s knowledge of the product’s environmental impacts, and some item comparisons may have caused confusion when assessing the least carbon-intensive products. For example, a pineapple was compared to an apple for the carbon cost of transporting the fruit, and beef was compared to chicken for carbon costs in farming the meat. Additionally, Beattie and Sale (2009) did not attempt to validate their measure by using any other measures of environmental concern, or correlate the

measure with a behaviour with environmental consequences, offering little support that their measure was appropriate.

An alternative measure proposed by Schultz, Shriver, Tabanico, and Khazian (2004) is the implicit connectedness to nature measure. Employing a variation of implicit procedures, their measure had participants classify stimuli relating either to 'self' or 'other' (instead of the typical 'good' or 'bad' attributes), and classify words characterising nature (e.g. birds, trees) or a built environment (e.g. factory, street) selected for their "face validity" (Schultz et al., 2004, p. 34). The implicit connectedness to nature scale has some positive results suggesting validity: experiencing an enjoyable natural environment (such as a park) improved positive implicit connection to nature (Schultz & Tabanico, 2007), and stronger positive connections to nature were found in conventionally pleasant seasons (e.g. Spring) whilst explicit measures reported no differences (Duffy & Verges, 2010). The implicit connectedness to nature measure has been criticised however, for using overly positive items that may influence results in favour of pro-nature preferences: in several experiments Verges and Duffy (2010) reversed the direction of expected effects by using positively biased words for the built environment (e.g. toy, trophy) and negatively biased words for nature (e.g. fungus, bee). A rebuttal defending the implicit connectedness to nature measure was published by Bruni, Chance, Schultz, and Nolan (2012), reporting their own manipulations of word valances, and found no differences or reversal in scores. This debate on stimuli properties seems likely to continue.

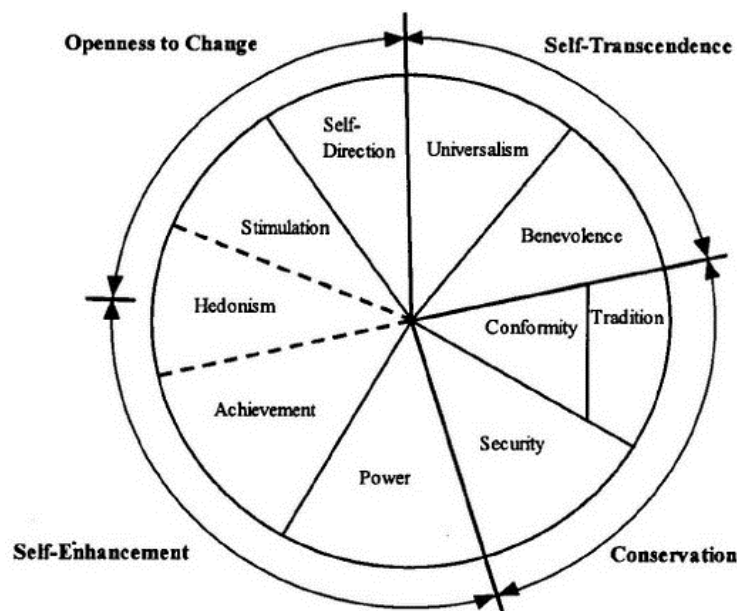
Difficulties with environment-based implicit measures are largely due to two factors. First, the vast majority of implicit measures are relative, and require a clear separation (e.g. Black or White) or a continuum (e.g. Rich to Poor) with recognisable opposites for comparison (Lane, Banaji, Nosek, & Greenwald, 2007). Unfortunately there is no immediate opposite to 'environmental concern', and several related words or characteristics also lack a clear opposite (such as the word 'ecology'). Methodology investigations for implicit measures highlight the importance of suitable categories, and have demonstrated that misapplication of categories can cause serious variation in results (Brendl, Markman, & Messner, 2001).

The second complication with implicit measures is the requirement for valance-balanced stimuli. Words can often have positive or negative connotations attached to them, which automatically generate positive or negative affective responses (Fazio, 2001). When designing stimuli for implicit approaches, the chosen stimuli should ideally have neutral valance (with no obvious positive or negative associations), or have an equal valance (so that all items are positively biased, for example). Difficulties arise when sets of stimuli are heavily valance imbalanced. For example, natural stimuli (e.g., flower, kitten) would likely cause confounding influences if compared with non-natural stimuli (e.g., sewer, concrete) without

accounting for valance. Though an obvious example, words representing environmental issues can induce strong negative views (e.g., pollution, deforestation) which may bias results (Verges & Duffy, 2010), and valance imbalance can reverse the direction of established effects, demonstrated by manipulating implicit preferences for insects and against flowers (Govan & Williams, 2004).

### 6.2.2 The emergence of Values within Environmental Research

A potential solution to the problem of placing environmental concern on a balanced continuum comes from the recent movement in environmental psychology to focus less on environmental *attitudes*, but instead to examine people's environmental *values* (Steg & Nordlund, 2012). An attitude can be defined as "a summary evaluation of an object or thought" which has been temporarily constructed from pre-held views (Bohner & Wänke, 2002, p. 5). On the other hand, values are widely viewed as a more stable and fixed constructs (Stern, 2000), that can vary in importance, and serve as guiding principles in daily life (Schwartz, 1992). A key benefit of using values when considering environmental concern is their efficiency: there are fewer values when compared to the array of environmental attitude constructs (Dunlap & Jones, 2002), and the abstract nature of values can be adapted to a range of applications (De Groot & Thøgersen, 2012). Values also offer a more stable unit of measurement when assessing personal values. Unlike attitudes, which are effectively the product of values (Stern & Dietz, 1994), values are a more fundamental construct that may be more useful when assessing individual views.



**Figure 18: Illustration of the circular relationship between motivational values. Adapted from "Are there universal aspects in the structure and contents of human values?" by Schwartz, S. H., 1994, *Journal of Social Issues*, 50(4), p. 24. Copyright by Wiley Online Library.**

The development of values within environmental research largely originates from the work of Schwartz (1992, 1994) who published two highly influential reports demonstrating the international existence of a two-dimensional grid of values (Figure 18). The more vertical axis of the two-dimensional grid indicates how people rate the importance of values for conservatism (e.g. security and tradition), to those that highly rate openness to change (e.g. autonomy and independence). The horizontal axis contrasts one extreme termed Self Enhancement (e.g. personal gain, power and wealth), against the opposite extreme of Self-Transcendence (e.g. universalism and benevolence) (Schwartz, 1994). The relationship between values has found to match the circular model well, with negative or null relationships between opposing values, and experimentally priming values led to deactivation of opposing value behaviours (Maio, Pakizeh, Cheung, & Rees, 2009). Within the circular value model, the second axis is especially important for environmentalism, since self-transcendence values have been a useful predictor for environmental behaviours by a number of researchers (see De Groot & Steg, 2007). Moreover, a recent meta-analysis collating 13 reports of materialistic values (strongly linked to egoistic values) found a moderate to strong link between greater materialism with lower environmental concern and behaviour (Hurst, Dittmar, Bond, & Kasser, 2013).

Expanding the use of values, Stern and colleagues (Stern & Dietz, 1994; Stern, Dietz, & Kalof, 1993) proposed an additional value orientation directly related to pro-environmental views. In several studies and reviews of literature, they suggested that while people may wish to protect the environment for altruistic reasons, there was evidence that people may be separated by their concern for the environment itself, rather than just to help others; Stern and Dietz (1994) offer the example of choosing between protecting people's jobs or protecting historic woodland; both falling under a self-transcendence value orientation. Amalgamating concepts previously discussed by several authors (De Groot & Steg, 2008), Stern and his co-authors (Stern & Dietz, 1994; Stern et al., 1993) presented a tripartite model of value orientations to help explain environmental behaviour; Egoistic (concern for yourself), Altruistic (concern for others), and Biospheric (concern for nature).

However, a complication with the tripartite construct of values is the difficulty in separating the latter two constructs: Altruism and Biospheric values. De Groot and Steg (2008) note a number of publications that have attempted to separate the two proposed values, though results often only confirmed the original separation between self enhancement (i.e. Egoistic) and self-transcendence (i.e. Altruistic) values. Some publications reported the successful separation of Altruistic and Biospheric values, though these often used exploratory methods that made conclusions difficult (De Groot & Steg, 2008). Schultz (2001) used Confirmatory Factor Analysis to demonstrate the validity of the tripartite model, though some



methodological issues present complications. Schultz (2001) asked respondents to rate their level of concern that environmental problems would have on three areas: personal effects (e.g. health), altruistic effects (e.g. all people), or biospheric effects (e.g. birds). But the survey assumed that all participants were actually concerned about environmental damage, and questions were also extremely focused; for example, questions for altruistic values were only focused on people and not on wider concepts (e.g. Justice) specified in Schwartz' Value Theory (1992, 1994).

Noting the lack of substantial investigations to define the tripartite model using confirmatory methods that focused directly on values, De Groot and Steg (2008) used a selection of terms from Schwartz's (1992) original values, with additional items added through three investigations, and developed a value scale that defined the tripartite separation of values. Their measure of value orientations uses 13 values for participants to score for their importance to themselves (including a value indicating a value indicating the value was against their own values), giving a score for each value orientation. The measure has received good support, with results suggested the validity of the measure across five countries (De Groot & Steg, 2007), and a comparison of values, concern of environmental impact, and NEP scores indicated that values were generally stronger predictor for environmental activism (Steg, De Groot, Dreijerink, Abrahamse, & Siero, 2011).

### **6.2.3 Applying Values to Implicit Measures**

With a clear divide between Egoistic and Biospheric values, the work by De Groot and Steg (2007, 2008) may serve as the ideal opportunity to apply an implicit measure of environmental concern. However, to the best of my knowledge, there are no implicit measures of value orientations. Some implicit measures have been used to tackle more abstract concepts such as personality traits (Boldero, Rawlings, & Haslam, 2007) or clinical topics such as anxiety (Greenwald et al., 2009), but value orientations remain untested. In his conceptual review on values, Maio (2010) notes that researchers have often considered values as conscious, easily accessible constructs, and that it may be time to explore them using implicit methods. In the search for implicit measures of values, Maio (2010) suggests three main difficulties; the need for opposing categories, the range of values that fit under one orientation, and the use of good/bad in implicit tasks while values are measured on importance.

For the first two problems highlighted, I believe that the De Groot and Steg (2007, 2008) framework can act as the basis for an implicit measure. First, Maio (2010) highlights that values may not have an opposite category against which to contrast, and suggests implicit measures that do not require a contrast category may be used (see the methodology section for this consideration). However, as described above, a key benefit of considering Egoistic versus

Biospheric values is their contrasting views; evidence supports the diametric links to environmental attitudes and behaviour (De Groot & Steg, 2007), with egoistic influences linked to reduced environmental views (Hurst et al., 2013), and that value orientations can be opposed (Maoi, Pakizeh, Cheung, & Rees, 2009). The second problem is the complexity of evaluating values; Maio (2010) suggests that several items may be needed to establish measurement “across several values that serve related motives” (p. 32). Though this will be covered in more detail in the methodology section below, implicit measures require a range of different stimuli to represent an over-arching category to be evaluated (e.g. roses, daisies and lilies are used to represent the concept of ‘flowers’). This means that, again using the scale developed by De Groot and Steg (2007; 2008), there are several unique values that fall under the over-arching themes of Egoistic or Biospheric value orientations.

The third complication highlighted by Maio (2010) is that values use importance ratings for measurement, while implicit measures often apply good/bad contrasts (Teige-Mocigemba et al., 2010). Described in detail in section 6.3.3, using basic good/bad assessments in implicit measures can capture automatic preferences, while more complex terms (i.e., “important” or “unimportant”) can reduce the effectiveness of implicit measures (Nosek & Hansen, 2008). For the purposes of this chapter, a good/bad assessment was applied to stimuli, and not ratings of importance, to encourage more automatic responses. This means that I cannot claim that this approach is an implicit measure of values, but rather, it may measure implicit preferences toward value orientations. Though not a direct measure of values, it could be possible to infer that implicit preferences toward Biospheric values may reflect greater concern for the environment.

Though a challenging concept, I believe that it will be possible to develop a valid implicit measurement of environmental preferences by basing stimuli upon the Value Orientation measure developed by De Groot and Steg (2008). My goal in this chapter is to explore what implicit measures are available, to design the implicit test according to best practice, and then to test the validity of the implicit measure. Once satisfied with the measure, I hypothesise that users of sustainable travel mode users will demonstrate stronger implicit preferences to the environment than users of conventional travel modes. Ethical approval for this study was granted by the Department of Psychology Ethics Committee, reference: 12-138.

### **6.3 Developing the IAT**

To develop an implicit environmental measure, I needed to address three questions: which implicit measure would be used, how to construct the chosen implicit measure, and the stimuli and materials to use within the implicit measure. Each of these three areas is considered in some detail below, and outlines how my implicit measure of environmental concern was

established. Alongside the description of the environment IAT development, some of the theoretical issues within implicit tests will be discussed, and the chosen solutions to these issues.

### **6.3.1 Selecting an implicit measure**

With a huge range of procedures for measuring implicit preferences (De Houwer and Moors (2010) mention 18 different approaches), I will first need to briefly describe the formation of implicit preference tests before justifying my selected method.

Implicit measures can trace their origins back to the late 1970s, with the search to develop more subtle measures of inter-group relations that avoided self-presentation biases (Ferguson, 2007). Building on emerging research for automatic concepts and priming, Fazio, Sanbonmatsu, Powell, and Kardes (1986) published the first argument that alongside categorical knowledge, evaluations towards a stimuli may also be automatically activated by priming. Fazio et al. (1986) presented participants with a range of target words that were strongly positive or negative, but were categorically unrelated, and asked them to press one of two buttons to categorise the target word as “good” or “bad”. Prior to the categorisation task, they also primed participants with stimuli (words appearing for 200 milliseconds) that similarly varied in either positive or negative valance. Fazio et al. (1986) found that when the prime and target were of equal directional valance (e.g. “gift” and “sunshine”), participants were faster at classifying target word valances than when the valance was imbalanced (e.g. “death” and “sunshine”). This effect was termed the evaluative priming effect, and received substantial support in replications (Ferguson, 2007). The evaluative priming effect developed into the Evaluative Priming Task (EPT); by presenting priming stimuli of black or white faces, and measuring the difference in time to categorise the valance of words, implicit preferences for/against black faces may be inferred (Fazio, Jackson, Dunton, & Williams, 1995).

The method developed by Fazio and colleagues became one of the most popular implicit preference measures in psychology (De Houwer et al., 2009), but crucially, was rivalled by another: the Implicit Association Task (IAT: Greenwald et al., 1998). Instead of priming, the IAT was conceived from differences in implicit and explicit memory, arguing that general implicit cognition may also exist, and represented traces of past experience that may be explicitly rejected, or may not be accessible by an individual (Nosek et al., 2007). The IAT indirectly measures the strength of association between concepts by classifying exemplars into one of two paired concept categories, briefly outlined in Table 13.

**Table 13: Illustration of IAT category pairings**

	Left Category	Right Category
Congruent Pairing	Flowers & Good	Insects & Bad
Incongruent Pairing	Flowers & Bad	Insects & Good

An IAT has four concept categories: two target categories (e.g. Flowers versus Insects) and two attribute categories (e.g. Good versus Bad) which are paired in alternate sections of the task. During the IAT, participants are shown exemplars of target categories (e.g. ‘Daisy’ or ‘Wasp’) and attribute categories (e.g. ‘Love’ or ‘War’) and asked to classify each item into a combined category, typically using a left or right key response. The combined categories can either be congruent, where the target and attribute category are assumed to be associated, or incongruent, where the categories are mismatched. The underlying principle is that when concepts are congruent and strongly associated (e.g. Flowers and good), then categorisation is faster than when the concepts are incongruent, or negatively, associated (e.g. Flowers and bad).

In determining which implicit methodology to use, it became apparent that the IAT would be the strongest option for three main reasons. Firstly, the IAT has experienced a meteoric rise since its inception; over 450 publications have directly used or evaluated the method (Teige-Mocigemba et al., 2010). The popularity of the IAT has led to a huge range of topics explored using the method and a vast amount of research evaluating the methodology (Ferguson, 2007), allowing several meta-analyses to evaluate and verify IAT results across a range of topics (Greenwald et al., 2009; Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005). Additionally, by placing various forms of the IAT online, the developers of the IAT also deliver a powerhouse for methodological investigations (Nosek, Banaji, & Greenwald, 2002): examples include using datasets of between 4,447 and 27,220 participants when testing different IAT methodologies (Nosek, Greenwald, & Banaji, 2005), and using 107,709 participants across seven studies that explore external influences on IAT scores (Nosek & Hansen, 2008a).

Secondly, investigations into methodological properties and results favour the IAT. In their normative review of IAT and EPT measures, De Houwer et al. (2009) conclude that the IAT generally shows larger effect sizes, and is a more reliable method for testing individual differences than the EPT. Using online tests and a total sample of 23,413 participants, Bar-Anan and Nosek (2012) compared the effectiveness of seven popular implicit measures. Testing for known group differences, reliability, and psychometric stability (e.g. handling missing data), Bar-Anan and Nosek (2012) found that the IAT outperformed other implicit methods on the majority of measures, with the EPT showing weak reliability and smaller links to known-effects.

The third reason to favour the IAT is because results from the EPT can be influenced by individual stimuli, and not only the general target category in question (Olson & Fazio, 2003). In contrast, an experiment by De Houwer (2001) demonstrated how the same stimuli of photographs of basketball players or politicians could show opposite IAT effects if the categories were described as either Black/White faces, or Sportsman/Politician. Further analyses indicate that IAT effects are based upon the category that stimuli are grouped under, and are less influenced by individual stimuli (Mitchell, Nosek, & Banaji, 2003; Nosek et al., 2005). Stimuli effects are particularly important, since I am attempting to use abstract concepts of Egoistic or Biospheric values, which need to be clearly defined for participants without confounding effects. Given these three broad benefits, the IAT was selected as the method for this chapter.

However, an additional method was chosen alongside the IAT, but was later removed. The IAT is a relative measure of preference between two options (Lane et al., 2007), and would not be able to compare all three values for environmental concern (De Groot & Steg, 2008). For example, the IAT can compare Egoistic against Biospheric value preferences, but would exclude Altruistic values. As an alternative to relative measures of implicit preference, such as the IAT, are several techniques designed to evaluate one concept individually. Known as single target category measures (Teige-Mocigemba et al., 2010), these methods evaluate implicit preferences towards one concept (e.g. Flowers), without requiring a contrasting group (e.g., Insects). The most popular single target category is the Go/No-Go Association Task (GNAT; Nosek & Banaji, 2001). Based in part on signal detection theory (Teige-Mocigemba et al., 2010), participants press only one key when words appear that relate to the target category or words for the required attribute category. Single target category tests were supported by Maio (2010) in his review of values, and the GNAT has received some promising support for validity and reliability (Bar-Anan & Nosek, 2012; Teige-Mocigemba et al., 2010). Initially, the GNAT was included as a secondary measure for implicit preferences for each value group, but as described in results for Study 4, the method proved difficult and unreliable. The GNAT is mentioned here, since it was a factor that required consideration when designing the stimuli, and to clarify that single target category methods were considered as an option during the design stage.

### **6.3.2 Establishing the Procedure**

As mentioned, the procedure of the IAT has been assessed by a number of researchers. The original IAT design developed by Greenwald et al. (1998) used 5 ‘sets’, or ‘blocks’, that required participants to classify items into categories, concluding that 25 trials (i.e. classifying 25 stimuli exemplars) within each of the 5 blocks was an optimum strategy. As the IAT grew more popular, particularly with publicly available access to IATs on the internet, Greenwald,

Nosek, and Banaji (2003) presented the first systematic analysis of IAT procedure effects from thousands of participants and advised the use of 7 blocks of trials for participants. The use of 7 blocks for the IAT test has continued, with an advised change by Nosek et al. (2005) in a further analysis of huge online data results, advising the category change block (Block 4) to include 40 trials to reduce order effects when switching categories. The final chosen procedure for the IATs within this study are thus based upon these analyses, and shown below in Table 14.

**Table 14: Outline structure of the Implicit Association Task (IAT)**

Block	Number of Trials	Left Key Response	Right Key Response
1	20	Category A	Category B
2	20	Good	Bad
3	20	Category A + Good	Category B + Bad
4	40	Category A + Good	Category B + Bad
5	40	Category B	Category A
6	20	Category B + Good	Category A + Bad
7	40	Category B + Good	Category A + Bad

To avoid ordering bias of pairing categories with ‘good’ or ‘bad’ first, Nosek et al. (2005) found that increasing Block 5 to include 40 trials effectively removes any ordering effect; though they advise randomising the order of pairing as a secondary precaution. Indeed, a later review by Nosek et al. (2007) acknowledged that the order of congruent or incongruent target and attribute categories has an influence, so randomisation of the order will be used in the current method.

For the attribute categories, the original IAT design used attribute category titles “Good” or “Bad”, though an alternative offered by Olson and Fazio (2004) is to use attribute category titles “I like” or “I don’t like”. Terming the possible influence of societal views as “extrapersonal associations” (p. 653), Olson and Fazio (2004) argued that the IAT may reflect society’s view of target category, but is not reflective of a person’s own views; for example a healthy behaviour may be publicly recognised as beneficial, but disliked by the individual. This view however has been challenged by an extensive evaluation using 7 studies with over 100,000 participants, concluding that IAT effects represent individual preferences independent of societal views (Nosek & Hansen, 2008a). Additional research using a comprehensive number of participants found that using personal “I like” attribute methods led people to consciously evaluate individual items that alters the IAT assessment (Nosek & Hansen, 2008b). As such, this study will employ the use of conventional Good/Bad attribute categories.

The issue of timing between the presentation of stimuli, from the time from one successful trial to the next, has been evaluated with no differences found in the range between

150ms and 750ms (Greenwald et al., 1998). Therefore, 150ms between stimuli was selected to facilitate a quicker and more convenient time for participants.

To interpret IAT results, a scoring algorithm for the IAT effects was based on recommendations by Greenwald et al. (2003) from their large-scale analysis of IAT data. The algorithm for calculating the IAT effect is best described as a series of steps shown below:

1. Use data from blocks 3, 4, 6, and 7
2. Remove trials with latencies >10,000ms and remove subjects with >10% trials with latencies <300ms
3. Compute mean of latencies for correct answers within each block
4. Compute pooled SD for all trials in block 3 and 6, and another for 4 and 7
5. Replace incorrect answer latencies with block mean + 600ms
6. Average latencies for each of the four blocks
7. Calculate difference between Block 6 and 3, and also for Block 7 and 4
8. Divide each difference by the relevant pooled SD figure
9. Average the figures from Step 8 to give the IAT effect:  $D$

This relative measure  $D$  is comparable to Cohen's (1988) effect size  $d$ , and may be interpreted along similar conventions for small, moderate, and large effects (Greenwald et al., 2003). While the original IAT reported mean reaction speeds for conditions (Greenwald et al., 1998), the variability in reaction speeds between different people could hide the actual difference in reaction speeds for each person's assessment of conditions, which led to the formation of the scoring algorithm. The scoring algorithm has received criticism that it was created by comparing IAT effects with explicit measures, which may not reflect automaticity, and call for further evaluations for the scoring algorithm (Wentura & Rothermund, 2007). That said, recent research has investigated several variations of scoring algorithms using a Dutch dataset of 2,981 participants who completed depression-related IATs two years apart (Glashouwer, Smulders, de Jong, Roefs, & Wiers, 2013). They found that the conventional  $D$  measure was the strongest predictor for behaviour, for correlations with explicit measures, and performed well for internal reliability over the two-year period. As the most common method of interpreting IAT effects (Teige-Mocigemba et al., 2010), and with increasing support (Glashouwer et al., 2013), the  $D$  algorithm was used.

Lastly, it must be considered that the IAT is not performed in isolation, but is often included alongside other measures (e.g. survey measures) that may influence results. For example, there has been debate whether completing an explicit measure for a topic before an implicit measure could enhance results by priming consideration of the topic, or whether it may confound results by creating a bias for the explicit response by forcing conscious

evaluation (Teige-Mocigemba et al., 2010). A meta-analysis of 122 IAT effects found no significant link between explicit/implicit order and IAT results (Hofmann et al., 2005). Additionally, Nosek et al. (2005) found no evidence of explicit/implicit order effects in their online mega-study of IAT methodology, though still advise randomisation of tasks as some experiments have shown order effects. Given this advice, full randomisation of explicit or implicit measure order will be used.

### 6.3.3 Establishing the Stimuli

An essential part of the IAT is to accurately demonstrate the categories to be evaluated; both the target categories (i.e. the categories we wish to evaluate implicit preferences towards) and attribute categories (i.e. the positive/negative items used to assign evaluations) need to be clarified (Teige-Mocigemba et al., 2010). As described earlier in this chapter, the formation of clearly defined and opposing categories is vital to the validity of an implicit measure (Brendl et al., 2001; De Houwer, 2001; Lane et al., 2007). The proposed solution stems from work highlighting three value orientations that can predict environmental behaviour; Egoistic, Altruistic, and Biospheric values (Stern & Dietz, 1994; Stern et al., 1993). More recent work using this framework established a valid measurement tool for the three values, developed by De Groot and Steg (2007, 2008). The measurement of the three orientations uses 13 values, which are then rated by participants for their importance as “guiding principle in their lives” (De Groot & Steg, 2008, p. 336) on a 9-point Likert scale from -1 (opposed to value) to 7 (extremely important) including a value for 0 (not important). Items from the Value Orientation measure are shown in Table 15:

**Table 15: Items from the Value Orientation measure (De Groot and Steg, 2008); respondents evaluated their importance as a guiding influence on their lives using a 9-point Likert Scale.**

Egoistic	Altruistic	Biospheric
Social power: <i>control over others, dominance</i>	Equality: <i>equal opportunity for all</i>	Preventing pollution: <i>protecting natural resources</i>
Wealth: <i>material possessions, money</i>	A world at peace: <i>free of war and conflict</i>	Respecting the earth: <i>harmony with other species</i>
Authority: <i>the right to lead or command</i>	Social justice: <i>correcting injustice, care for the weak</i>	Unity with nature: <i>fitting into nature</i>
Influential: <i>having an impact on people and events</i>	Helpful: <i>working for the welfare of others</i>	Protecting the environment: <i>preserving nature</i>
Ambitious: <i>hard-working, aspiring</i>		

Although these categories are more abstract than conventional categories (e.g. Black/White faces), it has been demonstrated that IAT effects can be shown using conceptually-complex categories, as long as participants are fully informed before the test what the category represents (Dewitte, De Houwer, & Buysse, 2008). Participants will then be given a full



explanation of the concept categories prior to the IAT, and I must also consider the representation of stimuli in some detail .

Implicit measures can use various stimuli types, often words or images to represent categories, or audio clips used on rare occasions (Nosek et al., 2007). One investigation explored IAT effects by comparing stimuli of varying levels of representation (e.g. black celebrities' names or stereotypical names of black people), and compared the use of words or pictures to enhance these effects. Results showed that words had a stronger level of representation toward categories than pictures, and were also linked to stronger IAT effects (Foroni & Bel-Bahar, 2010), validating previous support for words rather than images in implicit measures (Nosek et al., 2002). With evidence for words as more representative of a category, I then considered how many words would be required to define the category. In their comprehensive analysis of over 12,000 IAT responses, Nosek et al. (2005) note that while IAT effects can be observed with just two stimuli in a category, a minimum of four items is recommended; I chose five words to match the minimum and for convenience.

Stimulus words within an IAT must also consider their valance (the good or bad connotations they hold) as word valence induces automatic judgements that influence processing speed (Estes & Adelman, 2008). The confounding influence of word valence on IAT results has been experimentally demonstrated in race-related tests (Govan & Williams, 2004), and as mentioned, previous attempts to create implicit environmental-preference measures (Schultz et al., 2004) may have inadvertently confounded results by using imbalanced word valances (Verges & Duffy, 2010). An additional factor is the familiarity of words used within IAT measures. Meaningless words not previously encountered can skew results (Brendl et al., 2001) and more familiar words produce stronger effects, though variance in word familiarity appears to be far less problematic than word valance imbalances (Ottaway, Hayden, & Oakes, 2001).

For the stimuli design, inspiration was sought from the construction of questions by De Groot and Steg (2008), and tried to define the concepts into a single word for clarity and speed of reading. For example, for the concept of "*Social power: control over others, dominance*" I considered the words "Reputation" and "Prestige" as connotations of social power and standing. Using the questionnaire developed by De Groot and Steg (2008) gave 5 words for Egoistic values, but only 4 each for Altruistic and for Biospheric values. From discussions with colleagues, thesauruses, and reviewing publications, the list of words was extended to seven possible words that could represent each value, with the intention that the five most appropriate words would be used. The first draft of words are shown in Table 16.

**Table 16: First draft of stimuli indicating the three value orientations**

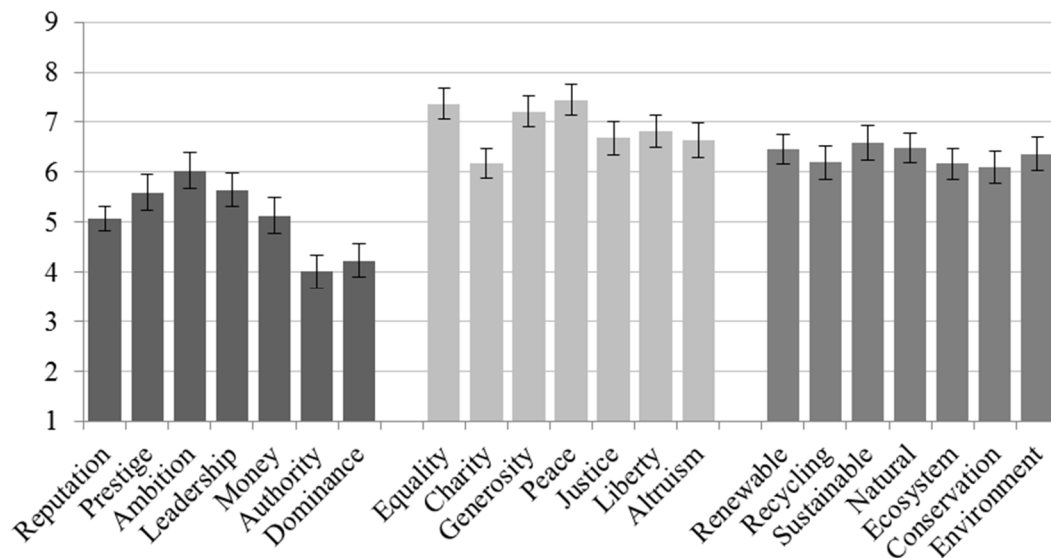
Egoistic Values	Altruistic Values	Biospheric Values
Reputation	Equality	Renewable
Prestige	Charity	Recycling
Ambition	Peace	Sustainable
Leadership	Justice	Natural
Money	Liberty	Ecosystem
Authority	Generosity	Conservation
Dominance	Altruism	Environment

Establishing equal valance of words across categories was first attempted by referring to the ANEW scoring of word valances (Bradley & Lang, 1999) as used by Verges and Duffy (2010) in their critique of Schultz et al.'s (2001) attachment to nature IAT (Schultz et al., 2004) for using valance imbalanced stimuli. The ANEW is however limited, and did not contain the majority of words selected for this study, nor offer suitable alternatives. Instead, a pilot study was designed that would measure the valance of words, and also check their suitability to represent their category.

#### **6.3.4 Valance of Stimuli Pilot Study**

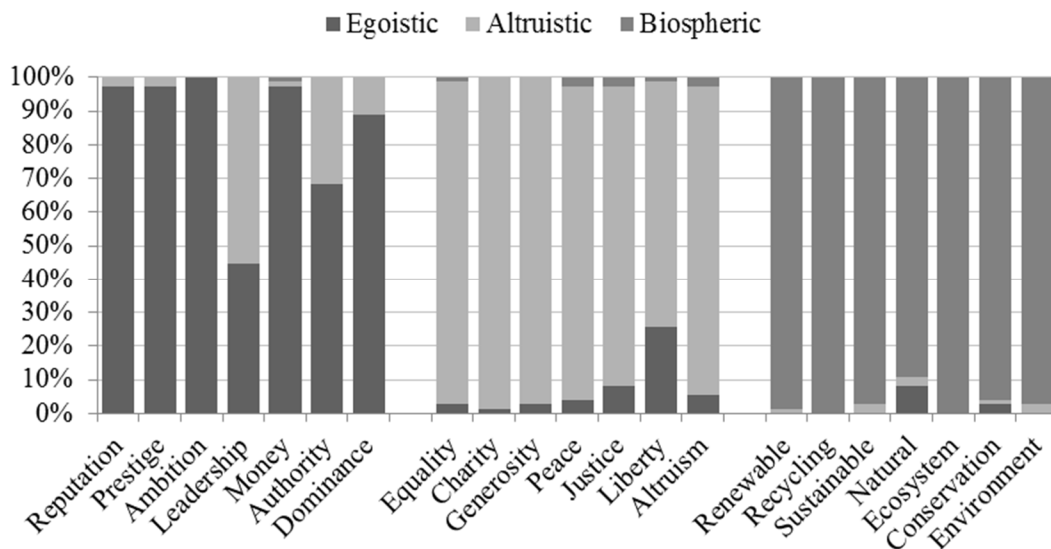
A survey was designed that included a 9-point Likert scale valance rating for each of the 21 words as either “Happy” or “Sad”, based on the ANEW methodology (Bradley & Lang, 1999). Respondents were also asked to categorise each of the 21 words to three categories defined as “Care for yourself”, “Care for others”, or “Care for the environment”. These labels were included instead of the names given by Stern et al. (1993) to make the category definitions more accessible to respondents. Age, gender, current country of residence, and respondent's primary language were also asked. English as first language was required, as I wanted to reduce the risk of confusion with the meaning of words that may be difficult for foreign language speakers.

Using the online-community at Reddit.com, the Pilot Study was advertised as a comparison of word ratings. The value of internet samples for increasing variety in participants whilst retaining validity has been documented (Casler, Bickel, & Hackett, 2013; Goodman, Cryder, & Cheema, 2013) and the use of Reddit.com has also been found to be comparable to conventional means while increasing sample variety (Casler et al., 2013). The survey attracted 113 respondents, though 21 respondents did not complete the survey task, and 9 respondents did not speak English as a first language. This left usable data from 83 respondents: 63.9% female, mean age of 24.8 years ( $SD = 6.9$ ) with the majority ( $n = 48$ ) from the USA, followed by Canada ( $n = 9$ ), UK ( $n = 6$ ) and South Africa ( $n = 4$ ), with remaining participants from the Netherlands, Australia, Sweden, Germany, France, and the UAE. Firstly, mean valance ratings for each of the words are shown in Figure 19.



**Figure 19: Valence ratings for the draft IAT stimuli words on 9-point Likert scale (Happy/Sad), grouped by value category and showing 95% CI**

Egoistic words' valence was rated lower than words for Altruistic or Biospheric values, notably "Authority" and "Dominance". This would indicate that some words may be problematic, as other words appear to show more positive valence. In addition, the proportion of the 83 respondents rating words as relating to one of the three categories is shown in Figure 20.



**Figure 20: Categorisation of draft IAT stimuli, as proportions of respondents assigning each of the 21 draft stimuli as representative of one of the three value orientations**

Classification of words indicated a generally positive result, though again some Egoistic words and the Altruism word "Liberty" generated some confusion.

To compile a set of balanced stimuli, lower rated words for the Altruism and Biospheric categories were selected to minimise the difference with the Egoistic words. As

for the strength of association with categories, selection of words for Biospheric was not an issue and the word “Liberty” avoided for Altruism. For Egoistic, whilst “Dominance” was a highly relevant word, the low valence would lead to a systematic imbalance that could influence IAT results. Though the level of representation can influence IAT scores (Feroni & Bel-Bahar, 2010), valence is arguably the more important characteristic to be controlled as it can even reverse the direction of IAT results (Verges & Duffy, 2010). These factors considered, the final words selected are shown in Table 17. Although egoistic words have a slightly lower valence rating than altruistic or biospheric value words, all three value sets contain positively-rated items.

**Table 17: Final stimuli words chosen, with mean valence ratings for items and group**

Egoistic Values (M = 5.54, SD = 1.52)			Altruistic Values (M = 6.77, SD = 1.48)			Biospheric Values (M = 6.22, SD = 1.50)		
Item	M	SD	Item	M	SD	Item	M	SD
Ambition	6.07	1.63	Charity	6.10	1.37	Recycle	6.12	1.58
Prestige	5.65	1.68	Justice	6.59	1.54	Ecosystem	6.07	1.42
Money	5.17	1.64	Altruism	6.53	1.65	Conservation	6.03	1.52
Reputation	5.13	1.13	Equality	7.25	1.44	Natural	6.40	1.37
Leadership	5.69	1.54	Peace	7.35	1.40	Sustainable	6.47	1.60

The IAT requires two sets of words: category words that denote the concept the participant has implicit attitudes towards or against, and attribute words for the positive or negative attribute to rate the category words. For the attribute words, measures of values are based on unipolar measures of importance, while implicit tasks predominantly use a bipolar measure of good/bad (Maio, 2010). Some researchers have suggested that implicit measures may employ more complex assessments, such as using “I like” or “I don’t like” to measure a respondent’s specific assessment of implicit stimuli (Olson & Fazio, 2004), and we may also apply “important” or “unimportant” attributes in an implicit task. But when investigating the effectiveness of the IAT using more complex attributes, these words increased the amount of conscious processing of test stimuli (Nosek & Hansen, 2008), negating the value of the IAT as an automatic preference measure. To preserve automatic assessment of the stimuli, it was decided that the current approach would employ good/bad assessment.

The first issue was choosing the attribute words, since a large number of IAT studies use words such as “peace” and “love”: words that could be confused with the category of ‘Altruism’. To avoid this issue, it was decided that attribute words would only consist of adjectives (e.g. ‘wonderful’), while category words would consist only of nouns. While it has been noted through meta-analyses that the use of adjectives instead of nouns is linked to lower explicit/implicit correlation (Hofmann et al., 2005), the effect is small, and I believe the

added benefit of differentiating target and attribute words outweighs the influence on comparative correlations. Selected attribute stimuli are shown in Table 18.

**Table 18: Positive and Negative attribute words for the implicit test**

Positive Attribute	Negative Attribute
Wonderful	Horrible
Delightful	Disgusting
Incredible	Terrible
Excellent	Awful
Fantastic	Revolting

Within the IAT procedure, differentiating between target and attribute categories may also be assisted by the use of displaying attribute items in a different colour, as recommended by De Houwer (2001). In the current study, and in randomised order, attribute and category words were differentiated by using either Blue or Black text. Having taken care to establish words that have generally positive valance and are reflective of complex concepts in a single word, the second stage of this study was the investigation of whether the words would reflect implicit environmental preferences.

### **6.3.5 Establishing the effectiveness/validity of the Environmental IAT**

To determine if my measure does reflect true environmental concern, I needed some criteria to demonstrate the validity of the environment IAT. The validity of implicit measures is a wide area of discussion, but can be viewed on two aspects: individual level effects, and group level effects (Teige-Mocigemba et al., 2010).

Individual level effects focus on correlations with explicit measures, other implicit measures, or predicting behaviour (Teige-Mocigemba et al., 2010). Correlating implicit measures with explicit measures has received a large amount of attention, with two large analyses on the topic. Hofmann et al. (2005) published a meta-analysis combining results from 126 studies (total  $n = 12,289$ ), and found an average effect size of  $r = .24$  between implicit and explicit attitudes. In their discussion, Hofmann et al. (2005) highlight that increased spontaneity of explicit measures was linked to implicit measures, but introspection and social desirability were not significant predictors of explicit/implicit relationships, suggesting that implicit/explicit measures are linked, but influenced by higher order processes. A second analysis by Nosek (2005) used data from the Harvard online IAT resource (total  $n = 6,836$ ) and reported a stronger correlation of  $r = .36$ . In his report, Nosek (2005) noted that greater self-presentation concern (i.e. greater social stigma of the topic) was linked to lower implicit/explicit correlations, and other moderators of increased correlations were: stronger evaluation strength, evaluating measures of polar opposites, and the distinctiveness of a person's own views against the norm. Both analyses suggest that implicit

measures are related to, but separate from, explicit measures of concepts, suggesting that implicit methods measure a facet of an underlying structure, but one that can be separate from explicit measures.

For the environment IAT, we would then want to see correlates in the expected direction with explicit measures; this can be achieved by measuring general environmental concern and personal values. For general concern, I used the New Ecological Paradigm (NEP) scale (Dunlap et al., 2000), a 16-item scale using a 7-point Likert measure, discussed in the introduction for its widespread use and reliability (Dunlap, 2008). For personal values, the scale by De Groot and Steg (2008) was used: 13 values rated on a 9-point scale indicating their importance. To assess the validity of the environmental IAT measure, there should be a positive correlation between NEP scores and Biospheric/Good IAT effects. For values, higher Biospheric/Good IAT effects should be positively correlated with higher Biospheric values, be negatively correlated with higher Egoistic values, and ideally show weak or no correlation with Altruistic values to indicate Biospheric values as a separate construct, although positive correlations with Altruistic values would still be compatible (De Groot & Steg, 2008).

The second area for IAT validity are group level effects where ‘universal’ attitudes may be expected (e.g., a preference for flowers over insects), known-group differences measured, or using experimentally-manipulated preferences (Teige-Mocigemba et al., 2010). Universal love for environmental issues isn’t likely given the trend for falling concern and rising scepticism (Whitmarsh, 2011), and inducing environmental preferences without first establishing the mere presence of environmental concern without manipulation could add confounding effects, so known-group differences will be investigated. The known-group approach assumes that members of a group will differ *a priori* on the topic in question, and this method of validity has shown the expected group differences in a number of topics such as race (Greenwald et al., 1998), homosexuality (Banse, Seise, & Zerbes, 2001), and vegetarianism (De Houwer & Bruycker, 2007). For environmental concern, it was decided that membership of an environmental organisation, such as the WWF or Greenpeace, would likely show stronger environmental concern. In an ideal world, it would be possible to compare environmentalists with anti-environmentalists, or to locate a group that exemplifies strong Egoistic values, but defining such groups would be difficult and there were no reliable sources of anti-environmentalist groups that could be found. Instead, comparing members with non-members of environmental groups should provide the required differences. Therefore, validation of the environmental IAT used membership of environmental groups, and will analyse differences between groups based on their IAT effect scores.

## 6.4 Study 4: Pilot Laboratory Test

For the first test of the environmental IAT, I sought a relatively small and accessible sample to establish whether the method could demonstrate the desired effects.

### 6.4.1 Method

Participants were informed they were completing a study on environmental attitudes and would take part in a reaction speed ‘game’ as part of the study, and given consent forms with relevant ethical information. The order of explicit or implicit task was controlled for, with participants randomly assigned using predetermined values generated by Random.org. For the explicit measure, participants were first asked to complete the Value Orientation Scale for Egoistic, Altruistic and Biospheric values created by De Groot and Steg (2008). Participants then completed the New Ecological Paradigm (Dunlap et al., 2000). Lastly, participants indicated their gender, age and whether they were active members, or donated money, to environmental groups or charities (giving the examples of Greenpeace and the WWF).

For the implicit measure, participants were informed they would be completing the reaction speed test, and instructed on the keys to use. The IAT was programmed using E-Prime software v. 2.0.8.90 (Schneider, Eschmann, & Zuccolotto, 2002), displayed on a 19” inch screen at 1280x1024 resolution, approximately 72cm from the participant. The order of Biospheric/Good or Egoistic/Good as the first set to be evaluated was counterbalanced randomly using E-Prime random number generator. Participants then read on the screen a definition of the two categories to be evaluated, to avoid confusion for the complexity of the topics (Dewitte et al., 2008). The description for words relating to “Care for Yourself” (i.e. Egoistic values) was:

*“Words will relate to things that are beneficial to an individual and improving a person's own life”*

The description given for words relating to “Care for the Environment” (i.e. Biospheric values) was:

*“Words will relate to things that benefit the planet's ecosystem and the environment”*

Once participants were content with the general theme of the words, they began the implicit task as specified in Table 14. Only after participants had completed both the implicit and explicit measures were participants informed of the nature of the study, were reminded of the confidentiality of their data, and given the opportunity to ask any questions.

### 6.4.2 Participants

Participants were recruited from two samples: psychology undergraduate students who took part for course participation credits, and members of university environmental groups. Unfortunately no environment societies existed at the University of Bath, so emails were sent to the nearby University of Bristol to recruit more participants. Contact was made with three societies from Bristol, and participants were offered £5 for the chance to take part. Since adverts were directly marketed to those already within the societies and not general students, I could be reasonably sure that Bristol volunteers held strong environmental views prior to the incentive. A total of 42 participants were recruited for the laboratory testing; 26 from the University of Bath (18 female, mean age = 18.85, SD = 0.73) and 16 from the University of Bristol (15 female, mean age = 20.8, SD = 1.7).

Participants were asked if they were members of, or donated money to, an environment-related group, which was used to classify participants. Of the 42 participants, 18 were members of environmental groups, including 2 students from the University of Bath (16 female, mean age = 20.71, SD = 1.61), and 24 were non-members (17 female, mean age = 18.75, SD = 0.68).

#### 6.4.2.1 Complications with the GNAT Procedure

My original intention was to use both the IAT and the GNAT for comparison, since the tripartite value orientation model is not fully accounted for using the IAT procedure, and the GNAT could theoretically identify implicit preferences towards each value orientation in isolation. However, during Study 4 described below, participants' feedback was extremely hostile to the use of the GNAT because of the task difficulty. During debriefing, participants reported that separating the three sets of words relating to abstract concepts while under time pressure was extremely stressful, and believed that the measure would not be suitable for a number of people. Though some researchers have found that the GNAT can be successfully used to measure each of the Big Five personality constructs (Boldero et al., 2007), arguably a similarly abstract concept as values, the current approach was deemed too difficult. Additionally, data from the 23 participants who completed the GNAT pilot study indicated that the GNAT measures showed no significant correlations with their explicit counterparts, and would actually trend towards negative correlations, as shown in Table 19.

**Table 19: Pilot Study correlations (n= 23) of GNAT and Explicit measures of values, \*p <.01**

Explicit	GNAT Implicit		
	Egoistic	Altruistic	Biospheric
Egoistic	.085		
Altruistic	-.125	-.024	
Biospheric	-.14	.575*	-.053



Given the large difficulty faced by respondents, and the poor relationship between the GNAT and explicit measures, I chose to remove the GNAT from the task. This complication meant I had to review the valance and categorisation results of the stimuli words, highlighted in Figures 19 and 20. Fortunately the pilot study results didn't suggest any serious complications: valance for Egoistic and Biospheric words were more closely matched than the now defunct Altruistic words, and there was minimal confusion between Egoistic and Biospheric words, indicating the categories and stimuli were well-matched. Removing the GNAT, the study proceeded using the IAT approach.

### 6.4.3 Results

Explicit measures were calculated from individual items, each demonstrating suitable Cronbach's alpha reliability scores; NEP  $\alpha = .80$ , Egoistic  $\alpha = .77$ , Altruistic  $\alpha = .83$ , and Biospheric  $\alpha = .92$ . IAT scores were calculated using the Greenwald et al. (2003) *D* algorithm, and higher scores reflect stronger implicit preference for Biospheric values. To evaluate individual differences and correlations with explicit measures, a Pearson's correlation matrix is shown in Table 20.

**Table 20: Study 4 Correlation Matrix for Values, NEP and the Environment IAT. \*  $p < .05$ , \*\*  $p < .01$**

	Egoistic	Altruistic	Biospheric	NEP
Altruistic	-.125			
Biospheric	-.14	.575**		
NEP	.091	.280	.546**	
IAT	-.318*	.308	.480*	.359*

Comparison of scores for the NEP between the 18 environmentalists ( $M = 5.48$ ,  $SD = .55$ ) and 24 non-environmentalists ( $M = 4.71$ ,  $SD = .49$ ) using independent samples t-test was significant (two tailed),  $t(41) = 4.789$ ,  $p < .001$  indicating that environmentalists had higher scores on the NEP. The calculated effect size for this difference was conventionally 'large', Hedge's  $g = 1.46$  (95% CI: 1.31, 1.62).

Group differences for explicit ratings of values were compared using independent samples t-tests. Egoistic values for environmentalists ( $M = 4.56$ ,  $SD = 1.12$ ) and non-environmentalists ( $M = 5.29$ ,  $SD = 1.22$ ) were equivalent,  $t(40) = 1.96$ ,  $p = .108$ , as were altruistic values for environmentalists ( $M = 7.67$ ,  $SD = 1.10$ ) and non-environmentalists ( $M = 6.98$ ,  $SD = 1.21$ ),  $t(40) = 1.97$ ,  $p = .056$ . Biospheric values for environmentalists ( $M = 7.82$ ,  $SD = 1.12$ ) were higher than non-environmentalists ( $M = 5.53$ ,  $SD = 1.20$ ),  $t(40) = 6.50$ ,  $p < .001$ , with a conventionally 'large' effect size, Hedge's  $g = 1.98$  (95% CI: 1.63, 2.32).

Additional to this difference in explicit Biospheric values, the comparison of IAT scores between environmentalists ( $M = 0.47$ ,  $SD = 0.38$ ) and non-environmentalists ( $M = -$

0.09,  $SD = 0.40$ ) was also significant,  $t(41) = 4.40$ ,  $p < .001$ ; environmentalists had stronger implicit preferences for Biospheric values than non-environmentalists. The calculated effect size for this difference was also conventionally ‘large’, Hedge’s  $g = 1.4$  (95% CI: 1.27, 1.52). All reported  $p$ -values have been corrected for multiple comparisons using the Holm-Bonferroni method.

#### 6.4.4 Study 4 Discussion

Results from Study 4 suggests that using words relating to biospheric or egoistic values in an IAT produced significantly different scores between environmentalists and non-environmentalists. Environmentalists showed significantly stronger implicit preferences for biospheric-value related words than for egoistic-value related words. IAT effects also correlated as expected with explicit measures. Although the GNAT method was rejected for inducing high stress in participants and reported little correlation to explicit measures, the stimuli for the IAT appears to function as expected.

### 6.5 Study 5: Online Sample

Results from Study 4 were very positive, but a sample of 42 university undergraduates is still a select sample to draw conclusions from. In order to extend the number of participants and to investigate the IAT method on a wider sample, I created an online version of my IAT to provide a secondary source of participants from a wider background.

#### 6.5.1 Method

Participants were recruited by advertising the study on the social network site Reddit.com, particularly targeting certain online communities relating to general interest, psychology, and environmental issues<sup>18</sup>. As mentioned earlier, online samples have been found to increase diversity in participant samples, with good reliability and correlations with traditional laboratory samples, including the use of Reddit.com (Casler et al., 2013; Goodman et al., 2013).

The study was advertised as a PhD project on environmental issues including a reaction speed ‘game’. Participants were directed to a website describing implicit attitudes and purpose of the study. The website also acted as a counterbalance, so that the link to take part in the study randomly assigned participants (using JavaScript code) to either the IAT or explicit section first. The survey was identical to Study 4, with additional questions on respondent’s primary language, and country of residence. English as first language was required to avoid confusion with words, and since there is some suggestion that language may

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<sup>18</sup>The study was advertised on the forum boards for: /r/samplesize, /r/psychology, /r/askreddit, /r/greenparty, /r/environment, /r/climatechange

influence IAT results (Ogunnaike, Dunham, & Banaji, 2010). No monetary incentive was offered, but participants could receive feedback on their results upon request. The online IAT was based upon the ‘Open Source, Web-based IAT’ (Mason & Allon, 2013), a JavaScript program hosted on my personal research webpage. I modified the IAT program code to match the 7-block IAT structure, personalised stimuli to include my chosen words, and added increased randomisation of category ordering and stimuli presentation.

### 6.5.2 Participants

In total, 154 logged into the study, though 31 respondents failed to either complete the explicit task or the implicit task, and 11 did not speak English as a first language, leaving 112 valid responses. Of the 112, 51 were female with a mean age of 25.7 years ( $SD = 9.3$ ). As an internet sample, respondents were asked which country they were currently living in; 63% were from the USA, 15% from the UK, 7% from Canada, 3% each from Australia and the Netherlands, with remaining participants from Austria, Mexico, New Zealand, Portugal, Singapore, Sweden and Switzerland.

As with the laboratory procedure, participants were separated into groups based on membership/contributions to environment groups. 28 participants were environmentalists (10 female, mean age = 31.4,  $SD = 13.4$ ) and 84 were non-environmentalists (41 women, mean age = 23.8,  $SD = 6.7$ ).

### 6.5.3 Results

Explicit measures were calculated with good Cronbach’s alpha reliability; NEP  $\alpha = .87$ , Egoistic  $\alpha = .74$ , Altruistic  $\alpha = .84$ , and Biospheric  $\alpha = .93$ . IAT scores were calculated using the Greenwald et al. (2003) algorithm. Results from the different measures were correlated, shown in Table 21.

**Table 21: Study 5 Correlation matrix for Values, NEP, and the Environment IAT. \* $p < .05$ , \*\* $p < .01$**

	Egoistic	Altruistic	Biospheric	NEP
Altruistic	.007			
Biospheric	-.032	.573**		
NEP	-.296**	.291**	.592**	
IAT	-.337*	.241*	.263**	.282**

NEP scores for the 28 environmentalists ( $M = 5.5$ ,  $SD = .67$ ) and 84 non-environmentalists ( $M = 4.7$ ,  $SD = .90$ ) through an independent samples t-test were significantly different,  $t(109) = 4.195$ ,  $p < .001$ . The effect size was calculated to be conventionally ‘large’,  $g = .91$  (95% CI = .76, 1.1).

Group differences for explicit value importance were compared using independent samples t-tests. For Egoistic values, environmentalists ( $M = 4.60$ ,  $SD = 1.06$ ) and non-

environmentalists ( $M = 4.94$ ,  $SD = 1.30$ ) were equivalent,  $t(108) = 1.24$ ,  $p = .432$ , and the same was found for Altruistic values (environmentalists  $M = 7.31$ ,  $SD = 1.16$  versus non-environmentalists  $M = 7.03$ ,  $SD = 1.42$ ) –  $t(108) = 0.95$ ,  $p = .346$ . Biospheric values for environmentalists ( $M = 7.94$ ,  $SD = 0.97$ ) and non-environmentalists ( $M = 5.99$ ,  $SD = 1.85$ ) were significantly different,  $t(108) = 5.21$ ,  $p < .001$ , with a conventionally ‘large’ effect size, Hedge’s  $g = 1.15$  (95% CI: 0.83, 1.46).

Comparing IAT scores for environmentalists ( $M = 0.36$ ,  $SD = 0.41$ ) and non-environmentalists ( $M = 0.03$ ,  $SD = 0.55$ ) using an independent samples t-test found a significant difference,  $t(108) = 2.91$ ,  $p = .012$ . Calculated effect size was conventionally ‘medium’ to ‘large’: Hedge’s  $g = 0.63$  (95% CI: 0.54, 0.73).  $p$ -values were all again corrected.

#### **6.5.4 Study 5 Discussion**

Using an online sample of 112 participants, Study 5 replicated the difference in IAT scores between environmentalists and non-environmentalists, showing a pro-biospheric preference from members of environmental groups. In comparison to Study 4, results were generally more mixed with smaller differences between environmentalists and general public on the IAT and NEP, and weaker correlations between the IAT and explicit measures. This may be due to the uncontrollable environments participants experienced when performing the IAT; music, disturbances, or uncertainty of test parameters for example. Also, given the abstract nature of the categories within the IAT, greater attention may be required to accurately categorise stimuli, which may be influenced by uncontrollable environments.

### **6.6 Study 6: Applying the IAT to Travel Mode Choice**

The previous tests suggest that the IAT measure can detect significant differences between environmentalists and general population, and shows expected links to explicit measures. Satisfied with the methodology, I wanted to see if the test could show interesting differences in preferences not previously detected by explicit measures. The inspiration for developing this IAT came from an apparent conflict between active and non-active travel mode user groups in the exploratory work of this thesis. Focus group responses (Chapter 3) showed that all user groups gave explicit concern for environmental issues, though non-active mode users appeared to show little connection or belief in the application of environmental protection. A large-scale survey (Chapter 4) of environmental worldviews using the NEP (Dunlap et al., 2000) then found no substantial difference between active and non-active mode user groups. With a discrepancy between explicit survey reports, against the more natural qualitative reports, this environmental IAT was created to establish if differences between active and non-active travel mode users groups may be shown implicitly, but not explicitly.

### 6.6.1 Participants

For a suitably large sample, two sources of recruitment were used. Firstly, an online version of the study was advertised on the internal noticeboard of the University of Bath during the summer vacation period for staff and postgraduate students. The study was advertised as testing a new measure of environmental concern, and respondents could choose to enter for a prize draw for 1 of 5 £10 vouchers as incentive. A total of 38 people responded, though one person failed to complete the survey, leaving 37 participants.

The second source of participants was obtained by hosting the online version of the IAT at a University Open Day for prospective undergraduates and their parents/guardians. A series of computers were set up in the Psychology department for visitors to try a psychological study, though participants often sat close by to each other, the room was kept at a low volume. The open day sample also used a modified version of the IAT that displayed a brief summary of their implicit score once they had completed both explicit and implicit tests as encouragement for participation. A total of 126 responses were logged from the open-day sample, though 7 failed to take the IAT and 16 failed to complete the survey. An additional participant was excluded for an incorrect response rate of 49%, leaving 102 participants. Evaluating the two groups, IAT scores for the Internal ( $M = .123$ ,  $SD = .449$ ) and Open Day ( $M = .032$ ,  $SD = .592$ ) were not significantly different,  $t(138) = .853$ ,  $p = .39$ , and were merged as one sample. Details of two samples and their combined demographics are shown in Table 22.

**Table 22: Demographic details of Study 6 participants from Online and Open-day sources**

	N	% Female	Mean Age	Age SD
Open Day	103	73.5%	28.3	15.9
Internal	37	63.2%	31.8	8.3
Total	140	70.7%	29.3	14.4

### 6.6.2 Methodology

Computers were set to an internal homepage giving details of the study as a measure of sub-conscious environmental attitudes, and giving information for consent and Data Protection. If participants agreed to take part, they were then given a link to an online survey recording their age, gender, recycling behaviour on a 1(Never) to 9(Always) Likert scale, chosen travel mode to work/study, whether they were a member of an environmental group, the NEP and the Value Orientation Scale. Participants then completed the online-version of the IAT, and were given feedback on their implicit scores once the IAT was completed, and then led to a debrief webpage with information on the IAT and links to email if questions remained. As in Study 4, participants used 19" inch screens at resolution 1280x1024, approximately 72cm from the participant.

### 6.6.3 Results

Explicit measures were combined and Cronbach's alpha reliability was good; NEP  $\alpha = .80$ , Egoistic  $\alpha = .74$ , Altruistic  $\alpha = .81$ , and Biospheric  $\alpha = .91$ . The Greenwald et al. (2003) *D* algorithm calculated IAT scores. Results from the explicit and implicit measures were correlated, shown in Table 23.

**Table 23: Study 6 Correlation Matrix for Values, NEP and the Environment IAT. \*  $p < .05$ , \*\* $p < .01$**

	Egoistic	Altruistic	Biospheric	NEP
Altruistic	.259**			
Biospheric	.131	.576*		
NEP	-.215*	.238*	.409*	
IAT	-.195*	.088	.192*	.277**

Comparing NEP scores for the 16 environmentalists ( $M = 5.4$ ,  $SD = .69$ ) and 124 non-environmentalists ( $M = 4.8$ ,  $SD = .74$ ), independent samples t-test found a significant difference  $t(138) = 3.209$ ,  $p < .001$ . The effect size was calculated to be conventionally 'large',  $g = .81$  (95% CI = .69, .93).

Ratings of explicit values between groups were compared using independent samples t-tests. For Egoistic values, environmentalists ( $M = 4.39$ ,  $SD = 1.14$ ) and non-environmentalists ( $M = 5.26$ ,  $SD = 1.22$ ) were different,  $t(138) = 2.70$ ,  $p = .024$ , with a conventionally 'medium' to 'large' effect size, Hedge's  $g = 0.71$  (95% CI: 0.51, 0.92). Altruistic values for environmentalists ( $M = 7.48$ ,  $SD = 1.62$ ) and non-environmentalists ( $M = 7.07$ ,  $SD = 1.32$ ) were not significantly different,  $t(108) = 1.15$ ,  $p = .253$ . Biospheric values for environmentalists ( $M = 7.39$ ,  $SD = 1.61$ ) and non-environmentalists ( $M = 6.16$ ,  $SD = 1.64$ ) were significantly different,  $t(108) = 2.83$ ,  $p = .02$ , with a conventionally 'medium' to 'large' effect size, Hedge's  $g = 0.75$  (95% CI: 0.48, 1.02).

Finally, IAT scores for environmentalists ( $M = 0.389$ ,  $SD = 0.49$ ) and non-environmentalists ( $M = 0.015$ ,  $SD = 0.55$ ) were significantly different:  $t(138) = 2.58$ ,  $p = .022$ , indicating a conventionally 'medium' to 'large' effect size Hedge's  $g = 0.68$  (95% CI: 0.59, 0.77). All t-tests are corrected for multiple comparisons.

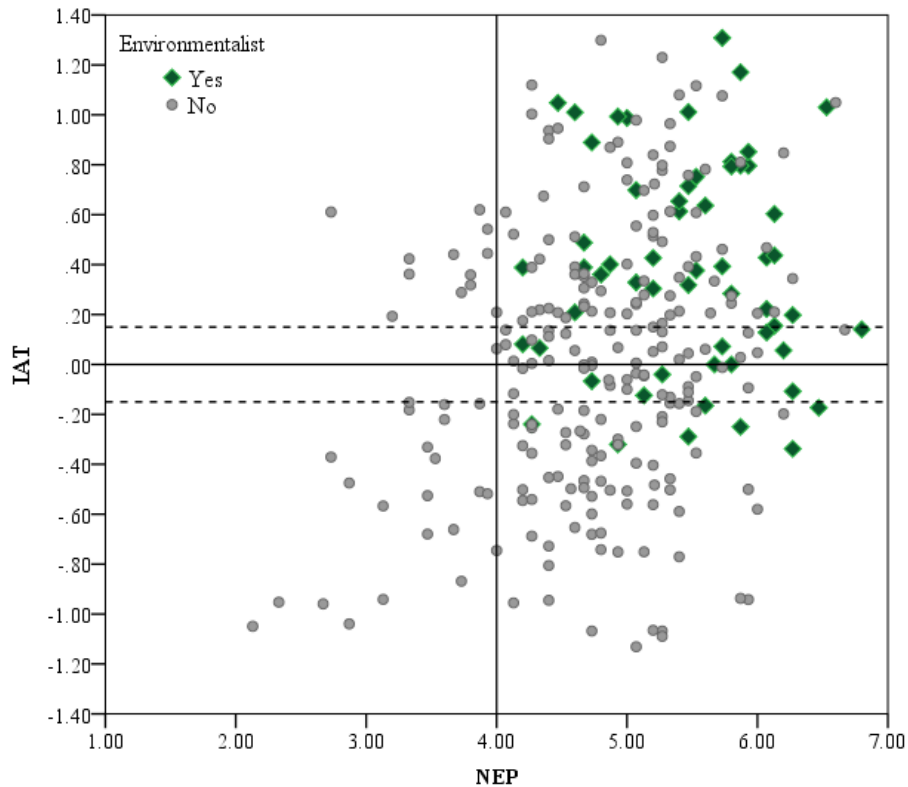
Self-reported main mode of travel to work or study place was also used to segment the sample. Within the sample of 140 respondents, 42% used the car, 20% used the bus and 13% used the train, 11.4% and 7.1% walked or cycled respectively, and around 6% used a mix of modes. With a relatively small sample of alternatives to car use, and given the similarities in the exploratory qualitative and survey work in Chapters 3 and 4, walkers and cyclists were combined to contrast against the other modes. These active mode users ( $n = 26$ ) were compared against non-active mode users ( $n = 115$ ) for scores on the IAT, NEP, and Value measures. Independent t-tests were used to compare active and non-active users.

Differences in Egoistic values between active ( $M = 4.77$ ,  $SD = 1.47$ ) and non-active ( $M = 5.23$ ,  $SD = 1.18$ ) were non-significant,  $t(139) = 1.696$ ,  $p = .092$ , Altruistic values for active ( $M = 6.99$ ,  $SD = 1.37$ ) and non-active ( $M = 7.16$ ,  $SD = 1.35$ ) were non-significantly different,  $t(139) = 0.570$ ,  $p = .570$ , and Biospheric values for active ( $M = 6.39$ ,  $SD = 1.81$ ) and non-active users ( $M = 6.30$ ,  $SD = 1.66$ ) were non-significantly different,  $t(139) = 0.265$ ,  $p = .792$ . For NEP values, active mode users ( $M = 4.82$ ,  $SD = 0.89$ ) and non-active mode users ( $M = 4.87$ ,  $SD = 0.73$ ) were non-significantly different,  $t(139) = 0.330$ ,  $p = .741$ , and IAT scores for active users ( $M = 0.72$ ,  $SD = 0.59$ ) and non-active users ( $M = 0.59$ ,  $SD = 0.55$ ) were non-significantly different,  $t(139) = 0.110$ ,  $p = .913$ .

### **6.7 Additional Analysis: Combined Sample**

For a general overview of respondents' scores when using the environmental IAT, and to increase sample size to improve statistical power, respondents from all three studies were combined into one dataset. The total number of participants who completed the IAT was 293; 183 were female (62.5%) with a mean age of 26.5 years ( $SD = 11.9$ ). The sample was divided into two groups; members of environmental groups ( $n = 60$ , 60.7% female, mean age = 28.9,  $SD = 12.4$ ) and non-members of environmental groups ( $n = 233$ , 62% female, mean age = 25.9,  $SD = 11.7$ ).

For a comparison of implicit and explicit measures, the total set of respondents has been plotted in Figure 21.



**Figure 21: Comparing NEP scores against IAT scores, with environmentalists highlighted against the general population using combined samples ( $n = 294$ ). Dotted lines indicate “small” effect boundary for IAT results.**

Using the cut-off point of 0.15 as a conventionally ‘small’ effect size for IAT effects (Greenwald et al., 2003), dotted lines across the y-axis indicate the region of negligible implicit preferences. The solid vertical line on the x-axis indicates the median point on the NEP range score, with higher environmental worldviews to the right of the line, and lower worldviews to the left. Results in Figure 21 show that although the majority of people indicated a positive environmental worldview using the NEP measure (87% with scores above at least 4), fewer people showed implicit preference for environmental values (57.2% above at least 0, 45% above 0.15). Comparing environmentalists against the regular population, we can see how environmentalists generally show both positive implicit and explicit measures of preference, compared to a number of people with high explicit preference but low implicit preference.

Using the combined sample of all participants, logistic regression analysis was used to predict environmentalist status. Five predictors were included in the model: each of the three explicit value orientations from De Groot and Steg (2008), NEP score (Dunlap et al., 2000), and the environment IAT effect. Using a stepwise approach to determine the strongest predictors, and using the Forward Likelihood Ratio to reduce bias (Field, 2009), results from the logistic regression are highlighted in Table 24.



**Table 24: Combined sample (N = 293) logistic regression predicting environmentalist status, \* =  $p < .05$ , \*\* =  $p < .001$ .  $R^2 = 25.6\%$  (Cox & Snell), 40.4% (Nagelkerke), Final model fit  $X^2(4) = 85.45$ ,  $p < .001$**

	B	S.E.	Wald	Exp (B)	95% CI
<i>Step 1</i>					
Biospheric	0.82	0.13	37.46**	2.27	(1.75, 2.96)
Constant	-7.13	1.02	49.01**	0	
<i>Step 2</i>					
Biospheric	0.85	0.14	39.22**	2.34	(1.79, 3.05)
Egoistic	-0.61	0.15	16.06**	0.54	(0.40, 0.73)
Constant	-4.38	1.15	14.57**	0.01	
<i>Step 3</i>					
Biospheric	0.80	0.14	34.19**	2.22	(1.70, 2.89)
Egoistic	-0.55	0.16	12.49**	0.58	(0.42, 0.78)
IAT	1.04	0.37	7.79**	2.83	(1.36, 5.86)
Constant	-4.50	1.14	15.57**	0.01	
<i>Step 4</i>					
Biospheric	0.67	0.15	20.74**	1.94	(1.46, 2.59)
Egoistic	-0.47	0.16	8.49**	0.63	(0.46, 0.86)
IAT	0.99	0.38	6.73**	2.68	(1.27, 5.65)
NEP	0.65	0.30	4.81*	1.92	(1.07, 3.44)
Constant	-7.34	1.76	17.37**	0	

Logistic regression results suggest that the best predictors of environmentalist status, in decreasing order of strength, are Biospheric values, Egoistic values, IAT effect, and then the NEP. Each predictor added significant variance reduction when controlling for the effects of other predictors.

## 6.8 General Discussion

This chapter outlines the design and validation of a new implicit measure of environmental concern. The Environment IAT is based upon the theoretical framework by Stern and colleagues (Stern & Dietz, 1994; Stern et al., 1993) that separates value orientations into three components; Egoistic, Altruistic, and Biospheric values. De Groot and Steg (2007, 2008) have developed a reliable explicit measure of these three value orientations, that pivotally separates Altruistic and Biospheric orientations; concepts previously difficult to distinguish. Inspired by items in their value orientation measure, a set of original stimuli was developed that strongly represented the opposing value orientations of Egoistic and Biospheric values, and with limited valance imbalance between the two stimuli sets. Using the Implicit Association Task (IAT; Greenwald et al., 1998) across three independent studies, strong differences in implicit preferences were found between environmentalists compared to general population, and implicit preferences correlated to explicit measures of environmental concern. When predicting membership of an environmentalist organisation, the implicit approach proved a

significant predictor of who was and was not a member of an environmental group, even when controlling for explicit values and attitudes. Although the implicit measure showed promising results, the initial goal of detecting differences in implicit preference for environmental concern between active and non-active travel mode users was unsuccessful, suggesting no differences in implicit concern.

### **6.8.1 Validity of the Environment IAT**

The three studies included an initial laboratory sample of UK undergraduate students ( $n = 42$ ), an online sample of participants from across the world ( $n = 112$ ), and a convenience sample of general population from the UK ( $n = 140$ ). Two approaches were used to establish the validity of the Environment IAT, correlations with explicit measures and known group differences, and both suggest strong support for the methodological approach. When developing their value orientation measure, De Groot and Steg (2008) note that Biospheric and Egoistic values may have opposing influences on sustainable behaviour, given their representation of Schwartz's (1992) polarised self-enhancement/self-transcendence value orientations (see also Maio et al., 2009). In all three studies, IAT scores (higher effects indicating a preference for the environment) were negatively correlated with explicit Egoistic values, and were positively correlated with explicit Biospheric values, supporting the Egoistic/Biospheric contrast. Additionally, IAT scores were not significantly correlated with explicit Altruism scores in Study 4 and 6, and were positively correlated in Study 5. De Groot and Steg (2008) demonstrated that Altruistic and Biospheric values are separate constructs, but the two orientations are connected, indicating that the IAT successfully differentiated Altruistic and Biospheric values in two of the studies, but remained positively linked to Altruistic values (as theoretically expected) in Study 5. Also, IAT results in all three samples showed positive correlations with NEP scores reflecting a person's environmental worldview (Dunlap et al., 2000). The positive correlation with a secondary measure of environmental concern gives additional support to the IAT, suggesting that it measures some shared variance between implicit environmental values and explicit attitudes, notably since values inform attitude strength (Stern & Dietz, 1994). It is interesting to note that the NEP originated from a rejection of the Dominant Social Paradigm that favoured wealth and power (Dunlap & Van Liere, 1978); constructs remarkably similar to the value of Self-Enhancement proposed by Schwartz (1992, 1994), which later developed into the Egoistic value orientation (Stern & Dietz, 1994) used in this measure. Utilising personal gain as a counter-balance to environmental concern is evidently an enduring concept, supporting the use of comparing Egoistic and Biospheric values within the current method.

Validation of the IAT was also found in its ability to detect and predict group differences. Using membership of an environmental organisation (e.g. Greenpeace or WWF)

for categorisation, the three studies showed that environmentalists held stronger implicit preferences for biospheric value stimuli than the general population. Calculating effect size between groups and using Cohen's guidelines (1988), the difference in implicit preference was conventionally 'large' in all three samples, demonstrating the environmental IAT's ability to reliably measure expected group effects.

It must also be noted that conventional explicit measures using the value orientation measure (De Groot & Steg, 2008) and the NEP (Dunlap et al., 2000) both performed well, and reported large effect size differences between groups. In the combined analysis of all participants ( $n = 293$ ), the three explicit value orientations, the IAT effect, and NEP scores were included in a logistic regression to predict membership of environmental groups. Even when controlling for explicit value measures, the IAT remained a significant predictor of environmental status: supporting the validity of using the Environment IAT approach to capture additional variation within behaviour over and above what can be captured through explicit methods (Greenwald et al., 2009). Additionally, the explicit value measure for Altruism was not a significant predictor of group status; again supporting Biospheric values as a separate construct uniquely linked to environmentalism (De Groot & Steg, 2007, 2008). It also appears that while explicit Biospheric and Egoistic values were the strongest predictors of group membership, the IAT outperformed the NEP measure in predictive utility. Reviews of IAT results, in a variety of spheres, conclude that they capture a separate, but related, component of attitudes and behaviour when compared to explicit measures (Greenwald et al., 2009; Hofmann et al., 2005; Nosek et al., 2005), and the Environment IAT has demonstrated this capability here. When comparing explicit and implicit measures, I argue that current results support using De Groot & Steg's (2007, 2008) value orientation measure in future research; explicit values were the strongest predictor to environmentalist status, and also for the simplicity of a survey instrument instead of a computerised reaction-speed task. Although the NEP was a significant predictor of group membership, value measure benefits are also supported by recent investigations into NEP and value differences; values can act as a stronger predictor of environmental behavioural intentions, personal norms, and policy acceptability (Steg et al., 2011).

It is interesting to note that Egoistic and Biospheric values showed no correlations to each other. Previous work also suggests that Egoistic and Biospheric values either show no correlation, or a weak negative correlation, despite often having significant opposing influences on sustainable behaviour and attitudes (De Groot & Steg 2007, 2008; Steg et al. 2011). As a requirement for the IAT, the two value orientations were set in opposition, and results demonstrated the practicality of this approach. However, it appears that applying the explicit approach that measures each value orientation individually is also useful, given that

environmentally-sustainable behaviour may be influenced by each of the three value orientations (De Groot & Steg, 2009).

### **6.8.2 No differences found for travel mode choice**

However despite the environmental IAT performing well as a predictor of environmental group membership, it did not show any differences between active and non-active travel mode groups, and the experimental hypothesis was not supported. When Study 6 participants were separated into active (bicyclists and walkers) against non-active travel mode users, no significant differences in values, environmental worldviews, or implicit preferences, were found. Although the limited sample size may not provide sufficient statistical power to detect differences, a more probable theory is that no differences in environmental concern exist. Previous studies have also found no effect of environmental worldview or personal identity as a predictor of travel mode choice (Whitmarsh & O'Neill, 2010), and survey results in Chapter 4 found no substantial differences even with a large sample size. This would suggest that even though stereotypes of active travel mode users often include having a 'green' identity or image (Daley & Rissel, 2011; Gatersleben & Haddad, 2010), actual environmental preference does not vary by choice of travel mode. Regarding the differences in environmental preferences found in Chapter 3, but now unsupported in the survey of Chapter 4 and the IAT results reported here, there are a number of possible explanations. As a qualitative approach, the small sample in the focus-groups may not have reflected general group beliefs, and biased the representation of environmental bicyclists and walkers to suggest differences that generally do not exist. Alternatively, user groups of different modes may have similar preference strength, but continuation of car use against choosing environmentally-friendly modes may highlight the attitude-behaviour gap often found in environmental behaviours (Kollmuss & Agyeman, 2002; Whitmarsh, 2009). Also, by keeping homogenous groups of bicyclists and walkers, focus groups may have made the identity and stereotypes of active mode users as 'green' more salient, which led to stronger reported support for environmental preferences.

### **6.8.3 Future application of the Environment IAT**

On a more positive note, and I believe for the first time, the results demonstrate that it is possible to use stimuli representing value-orientations in an implicit measure of preferences, though I cannot confidently state that the Environment IAT measures implicit values. Maio (2010) has suggested that implicit measures of values are possible, but he also described the difficulty with using Good/Bad assessments in implicit measures when values are defined by importance/unimportance. The Environment IAT measures a person's relative level of preference between the two extremes of Egoistic and Biospheric value orientations at an

implicit level, but additional work is required before fully stating that the method does measure personal values. Regardless of the consistent and clear correlations with the explicit value measures (which assessed the importance of values for the participant), and with group differences found, additional work is required to assess using value-based stimuli in implicit tasks. For example, by using opposing value orientations of Egoistic and Biospheric values that link to Schwartz's (1994) axis of Self-Transcendence and Self-Enhancement values, future work may develop implicit measures along the second axis of Conservatism and Autonomy values. Returning to the application of Egoistic and Biospheric values, the current approach delivers a relative measure of preference between these two extremes, but further work is needed to explore the relationship between the three value orientations; notably to include Altruistic values. It was unfortunate that implicit measures towards value orientation couldn't utilise the GNAT approach (Nosek & Banaji, 2001), which can offer a direct assessment toward a single category. Additional work on implicit value orientations may seek to develop further comparisons using the IAT approach, such as establishing the differentiation between implicit Altruistic and Biospheric values, or to develop a valid and user-friendly GNAT methodology for individual values.

Regarding possible use of the environmental IAT, there is a huge range of options that may be open to application of the method, and two broad areas are briefly considered here; predicting behaviour, and understanding psychological processes. Greenwald et al. (2009) argue that IAT measures are more useful when a topic is socially-sensitive, and given the concern for self-presentation biases when measuring environmental concern (Ewert & Galloway, 2009), the Environment IAT is ideally placed for investigative use. Although the concept of detecting "Green Fakers" (Beattie & Sale, 2009, p. 203) who don't disclose their true beliefs is an interesting concept, the IAT is not a method of identifying "true" beliefs, but a measure reflecting automatic and possibly inaccessible beliefs (Nosek et al., 2007, p. 282). The Environmental IAT could instead provide unique insight into people with conflicting implicit and explicit preferences; evaluating if certain behaviours are better linked to implicit or explicit measures. Although the IAT captures automatic preferences (De Houwer et al., 2009), in their review of IAT predictive utility, Greenwald et al. (2009) conclude that the controllability of the action (i.e. automatic behaviours versus conscious movements) made no difference in predictive ability; even highly controlled choices (e.g. voting behaviour) could be predicted by IAT effects. This opens a range of controlled or automatic behaviours that may be explored using the Environmental IAT. For example, choosing to publicly recycle one's waste may be a socially-sensitive act that could be explored (Barr, 2007), or even observing how an individual's uncontrolled eye movements relates to carbon-labels on commercial products (Hafner, Walker, Verplanken & Skippon, in prep).

Alternative applications of the Environmental IAT could explore the psychological concepts behind attitudes, decisions, and behaviour. A developing area of interest is the examination of sceptics' attitudes to climate change, and the Environment IAT may further assist investigations. For example Corner, Whitmarsh, and Xenias (2012) presented sceptics and non-sceptics with fake newspaper articles that challenged or supported climate change, and observed how both groups showed bias against opposing views. Corner et al. (2012) also asked participants to state whether sceptic's views had changed from reading opposing views, but found little explicit evidence of 'polarisation'; a strengthening of personal opinion when challenged by external views. The Environment IAT could evaluate how implicit environmental preferences may change when presented with new information, and whether automatic polarisation occurs, even when not explicitly reported. Previous implicit work has demonstrated that even after correcting previous negative information on fictional social subgroups as inaccurate, people maintain an implicit preference against the subgroup, while explicitly correcting their evaluations (Gregg, Seibt, & Banaji, 2006). This could also extend to how environmentalist subgroups or individuals are viewed; implicit evaluations of people are automatic and can develop into explicit biases (Ranganath & Nosek, 2008), and IAT predictive utility increases when predicting social-group judgements (Greenwald et al., 2009). For an individual's environmental concern, recent work suggests that Biospheric values may inform self-identity, which can mediate the relationship between values and environmental intentions and behaviour (van der Werff, Steg, & Keizer, 2013). Some IAT approaches can evaluate personal association with the categories using the attribute categories of 'Me/Not Me' (Greenwald & Farnham, 2000; Schultz et al., 2004), opening new approaches to explore Biospheric or Egoistic self-identity constructs.

A key strength of this study is the varied samples used to test the environment IAT, especially the online sample in Study 5. Recruiting samples through the internet has become more popular in social science research. Investigations comparing traditional laboratory samples with online recruitment suggest that online recruitment can deliver comparable validity and reliability, while increasing sample size and diversification of participant age, gender, and nationality (Casler et al., 2013; Goodman et al., 2013). Appealing to a worldwide audience, I requested participants who spoke English as their primary language to control for mistranslation confounds (given the complex nature of certain stimuli words). Interestingly, the range of countries was higher than expected; e.g. participants reported living in Singapore and Mexico. Though possible the participants primarily spoke English, participants could easily claim English as a first language. There is some suggestion that language influences IAT results (Ogunnaikie et al., 2010) though this was only applied directly to international relations: bilingual English/Spanish speakers showed increased preference for Spanish names

when the test instruction was in Spanish. A more likely result is that a secondary language in the current study could cause confusion rather than bias (given high speed recognition of complex words), but future work could attempt to control for this to avoid any potential complications. Additionally, results from the online sample gave weaker expected correlations and smaller IAT effects than the traditional samples. This may be due to the uncontrollable environments for online participants (e.g. ambient noise, distractions), or may also link to a number of non-English speakers experiencing difficulty with the stimuli words; further work is required to clarify these possible confounds.

I believe that the current approach using Egoistic/Biospheric value-based stimuli offers a more theoretically sound use of IAT stimuli than previous attempts using low/high carbon products (Beattie & Sale, 2009) or natural/built stimuli (Schultz et al., 2004). Using a pilot study, draft stimuli were evaluated for their suitability to represent categories and to establish a fairly even valance between words; vital factors within IAT design (Lane et al., 2007; Teige-Mocigemba et al., 2010). However the stimuli were not perfectly balanced and Biospheric stimuli were rated at a higher valance than Egoistic words. It is open to debate whether it is possible to perfectly balance two sets of words that relate to personal characteristics, also in part because the methods used (e.g. Likert scales) could very well be open to self-presentation biases: even those that skew results to enhance one's own opinion (Paulhus, 1991). But even with imbalanced valance, results from the Environmental IAT were consistent, theoretically sound, and predictive of actual behaviour. Improvements to the stimuli could certainly be made in the future, and additional work on designing a stronger set of stimuli may further enhance environment IAT effects.

In all three studies, environmentalists showed stronger implicit preference for biospheric value stimuli than non-members. Using known-group effects to determine IAT validity is a common approach that has shown good evidence for different applications of the IAT, but is dependent on the certainty of group's a priori views (Teige-Mocigemba et al., 2010). Using members of environmental organisations, I am confident that members would have a strong and positive interest in the environment, given the conservation work and themes undertaken by such groups. Yet even with environmentalists' strong positive views, the environment IAT should also explore the opposite end of the spectrum: those with stronger Egoistic orientations. Egoistic values relate to self-enhancement constructs that include ambition, power, and money (De Groot & Steg, 2008), which are characteristic of politically right-wing voters (Piurko, Schwartz, & Davidov, 2011). Applying the Environment IAT to members of right-wing political groups could provide an alternative approach to considering the IAT, and would theoretically demonstrate stronger Pro-Egoistic views. This is not to imply that Egoistic-value focused people do not care for the environment; Egoistic

values may also be used to encourage sustainability by highlighting personal gain and financial savings from sustainable behaviours (De Groot & Steg, 2009). Given the contrasting nature of the two value orientations however, seeking samples that hold strong pro-egoistic values would be beneficial to calibrating and evaluating the Environment IAT.

### **6.9 Conclusions**

In conclusion, using the orientations of Egoistic and Biospheric values is a successful approach to designing stimuli for use in implicit methods. The Environment IAT detected large differences between environmentalists and the general population, showed expected correlations with explicit measures of environmental values and worldviews, and was a unique predictor of environmentalist status even after controlling for explicit measures of values and attitudes. The Environment IAT offers a new approach to exploring environmentally sustainable behaviours, as well as understanding views and preferences relating to sustainability and climate change. As the first implicit measure of value orientations, future work may expand implicit approaches to other values, and hopefully validate this approach to other fields.





## **Chapter 7: An exploration-based method of investigating routine influences on a path-finding task**

*“ . . . I have no idea what the footpaths are, up to the university. . . ”*

**- Chloe, Car User (343)**

### **7.1 Abstract**

*Previous studies have explored how habitual behaviour may influence information searches, and reduce awareness of alternative options. The current study wished to expand upon this previous work, and explored whether it would be possible to simulate a habit, and whether this would influence information seeking. A computer-game task was designed for participants to plot a route across a fictional map, with conditions alternating between ‘car’ and ‘bicycle’ use. The map included a large shortcut available to bicycle trips, and three groups of participants varied in the amount of car use prior to using the bicycle. It was hypothesised that increasing car use routine would cause a negative effect on the amount that the bicycle was used to cross the park shortcut. Results indicated the opposite result, where greater prior car use led to greater use of the bicycle shortcut. A second study using a sample of regular bicyclists demonstrated that prior bicycling experience increased the use of the park shortcut. Results demonstrate the influence of breaking contexts to allow consideration of available information, and the importance of past experience. A novel method, the game demonstrated large effects using a minimalistic approach of information and repetition, suggesting the procedure involves strong psychological concepts that require further investigation.*

### **7.2 Introduction**

One of the results that emerged from the focus group discussions (Chapter 3) was the limited knowledge of walking routes to the university by car users. Highlighted in the opening quote of this chapter, some car users expressed uncertainty how they could actually walk to the university, despite the campus being well-served by pavements, footpaths, and nature trails. From the perspective of rational-choice models, such as the Theory of Planned Behaviour (Ajzen, 1985, 1991), information is weighed and considered before making an intention to perform the behaviour. To encourage behaviour change, providing information that is persuasive and relevant can lead to a change in beliefs, intentions, and actions (Bamberg, Ajzen, & Schmidt, 2003). Evidence supporting the effectiveness of information campaigns is, however, limited. People are biased toward information that supports their own views, instead of objectively considering new information (Hart et al., 2009), with implications for

information-based interventions. In a meta-analysis of various information-based health campaigns, Snyder et al. (2004) found only a weak effectiveness for changing behaviour, with the most effective area (encouraging seatbelt use) reporting a small effect size of  $r = .15$ . The impact of health interventions that specifically tailored information to suit participants is also questioned by a meta-analysis of 57 health promotion studies that found a very small effect size of  $r = .07$  (Noar, Benac, & Harris, 2007). Within transport, an experiment providing tailored feedback on car emissions found no change in behaviour, but instead found increased hostility to behaviour change, and actually reduced participant's environmental concern (Tertoolen, van Kreveld, & Verstraten, 1998), possibly due to cognitive dissonance (Festinger, 1962). More generally, a literature review by Chorus, Molin, and van Wee (2006) examined information provision for modal choice, and concluded that expectations for behaviour change were "mildly optimistic" (p. 351). Noting some potential benefits of providing information on alternative routes and other modes, the authors raise serious concerns about the "barriers" (p. 351) preventing information processing, including biased perceptions, mistrust of sources, and habitual behaviour preventing information from being processed (Chorus et al., 2006).

### **7.2.1 Habitual and Routine influences on information**

Habits can be easily conceptualised as behaviours that are automatic responses to contextual cues (Verplanken & Aarts, 1999), such as making a pot of coffee upon waking up each morning. However, habits are not defined by repetition of the behaviour (Ajzen, 2002), but instead are defined by the automaticity of the behaviour (Verplanken, 2010). Habit measurement is not based upon behaviour frequency but upon the degree of automaticity the behaviour involves (Verplanken & Orbell, 2003; Wood, Quinn, & Kashy, 2002), and researchers have observed the separation between behaviour frequency and behaviour habit strength (Lally, van Jaarsveld, Potts, & Wardle, 2010).

An automatic process, the influence of habits extends to cognitive processes, such as information searches. The influence on information was shown by Aarts, Verplanken, and van Knippenberg (1997) using a 'game' that compared habitual and non-habitual cyclists. The game presented 16 scenarios with hidden information on four variables (weather, luggage weight, distance, and departure time) before asking respondents to state their expected travel mode for each trip. Participants with stronger habits required far less information before deciding on a travel mode, which the authors argue was indicative of habits requiring less information to act upon (Aarts et al., 1997). In the same year, Verplanken, Aarts, and Van Knippenberg (1997) published an expansion of this method across three different studies, and further highlighted how habit influenced information seeking. Verplanken et al. (1997) found that participants with strong habits sought less information for both familiar and novel trips.

Even when asked to consider the importance of information, participants with strong habits gradually reduced the amount of information sought to make a decision, acting more on their habitual choices than presented information. Interpreting the lack of information sought when making a decision, the authors concluded that in cases of strong habit “...*the individual may not perceive such a situation as a choice at all, which thus precludes the consideration of situational cues and alternative options*” (Verplanken et al., 1997, p.556).

In addition to habits, investigations into the effect of routines upon information searches become an important consideration (Wood & Neal, 2007), especially with similarities between the concepts. Routines may be defined as “*an option that comes to mind as a solution when the maker recognizes a particular decision problem*” (Betsch, Haberstroh, & Hohle, 2002, p. 456). Although habits and routines both represent sets of learned solutions to achieve a goal, their separation is dependent on the automaticity found in habits that is not reflected in routines (Betsch et al., 2002), and habits are viewed as a subset of routines that have become automatic (Betsch, Fiedler, & Brinkmann, 1998; Betsch, Haberstroh, Glöckner, Haar, & Fiedler, 2001). Additionally, while it is conventionally viewed that habits take time and repetition to form (Lally et al., 2010; Wood & Neal, 2007) the influence of routines can be seen from only a few repetitions (Betsch, Haberstroh, Molter, & Glöckner, 2004). Routines and habits can be understood as methods to reduce cognitive load, a method of substituting difficult and effortful decision processes with shortcuts that require limited effort; a process sometimes known as the “Cognitive Miser” approach (Fiske & Taylor, 1984). To replace a constant re-evaluation of all information received and processed, we employ a range of mental shortcuts to facilitate daily life, such as heuristics (Tversky & Kahneman, 1974), habits (Aarts & Dijksterhuis, 2000), and routines (Bröder & Schiffer, 2006).

Routine mental shortcuts can cause complications however; a classic demonstration is the “Water Jar” problem designed by Luchins (1942). Each problem involves 3 jars of different sizes, with the goal of ending at a fixed amount of water. For example: given 3 jars that hold 21ml, 127ml, or 3ml, you would need to end up with exactly 100ml in one jar<sup>19</sup>. Ten water jar problems were given to participants, designed so the first seven could be solved using the same method, but the eighth problem required a new strategy. In addition, problems three to seven could be solved through a far easier method than the initial method. Results indicated a large majority of participants continued to use complex methods to solve the simple tasks, and 64% of participants failed to solve the eighth task when their routine strategy failed. Luchins (1942) termed this effect *Einstellung* (mechanisation of thought), where past experience clouded judgement for future problems. With striking similarity to the

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<sup>19</sup> Fill the 127ml jar, use this to fill the 3ml jar twice, and then fill the 21ml jar once.

influence of habits described above, Luchins (1942) uses the terms *Einstellung* and habituation interchangeably:

*“Einstellung-habituatation creates a mechanized state of mind, a blind attitude towards problems; one does not look at the problem on its own merits but is led by a mechanical application of a used method” (Luchins, 1942, p.15)*

Accounts of *Einstellung* effects that have blinded people to more successful and alternative tactics have even been shown in chess masters (Bilalić, McLeod, & Gobet, 2008a, 2008b), arguably experts in strategy consideration.

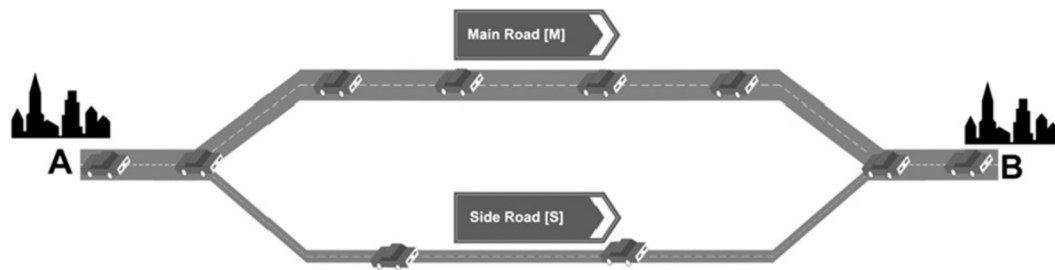
More recent work investigating the influence of routines not only identifies their impact on decision making, but also how external information fails to improve routine choices. In an economic-simulation based upon purchasing fertiliser products, Betsch, Brinkmann, Fiedler, & Breining (1999) had participants develop a routine choice in an environment offering information on choices on request. A week later, participants returned to the apparent same task, but ‘winning’ choices had changed. Despite the availability of information to inform participants, participants under time pressure returned to maladaptive strategies (Betsch et al., 1999). In a similar study, an economic-simulation based on renting construction equipment used by Betsch et al.(2001) required participants to select profit maximisation strategies while utilising information available. Participants varied in their initial routine strength, with weak (15 repetitions) or strong (30 repetitions) routines in the initial phase, before returning a week later to undertake a superficial similar test that required a change in strategy. Despite the availability of new information, participants with stronger routines were more likely to maintain an incorrect routine than the ‘weak’ routine group (Betsch et al., 2001).

A point raised by some routine studies is the influence of context change on routine behaviour. In two studies, one using a subtle change illustrating the purpose of roads to choose from (Betsch et al., 1998), and another explicitly stating that the context had changed and required thought (Betsch et al., 2001), routine behaviour decreased while information use increased. However, both studies evaluated a routine choice paradigm, while other investigations have focused upon routine strategies: that is, strategies require “procedures for combining attribute information” (Bröder & Schiffer, 2006, p. 904) rather than the individual choice itself. Across two studies examining routine strategy in an economic-based game, Bröder & Schiffer (2006) found a trend, but no significant effect of context change on routine strategy, even after explicitly informing participants the scenario had changed and required additional consideration. Results generally suggested that though context changes may

influence routine choices, there is limited influence upon routine strategies for considering and applying information.

### 7.2.2 Routine and Habitual influences for travel route choice

Alongside work comparing existing habits with information searches in travel mode choice (Aarts et al., 1997; Verplanken et al., 1997), researchers from other fields have explored how routines can influence decisions in a transport context. Largely covered by economists, transportation is a popular context for examining rational choice models that assume people strive towards utility maximization: that is, people decide on the best possible route for time or money (Avineri & Prashker, 2006). Research relies upon rational players who make decisions based upon the relative behaviour of other players to achieve mutually beneficial decisions, i.e. faster/cheaper trips.



**Figure 22: Representation of a binary route-choice experiment, and illustrative of similar designs in other route-choice experiments. Adapted from “Commuters Route Choice Behaviour” by Selten, R., et al. 2007, *Games and Economic Behavior*, 58, p. 396. Copyright 2007 by Elsevier.**

Often employing a decision task between two route choices (Figure 22), some work has demonstrated that utility maximisation can be achieved by participants when explicit and accurate feedback is immediately provided (Selten, Chmura, Pitz, Kube, & Schreckenberg, 2007). While models offering only a binary choices and perfect feedback demonstrate rational behaviour, other studies have attempted to add greater complexity for more naturalistic examples, and challenge the convention of rational choices.

Early proposals of non-rational considerations in route-choice were demonstrated in Monte Carlo simulations of route choice (again binary choices) where players were assumed to ‘learn’ and not receive instantaneous feedback to act logically on. Nakayama and Kitamura (2000) described simulated player behaviour as “delusion[al]” (p. 8), overly influenced by individual trips, and leading to habitual or “frozen” (p. 10) behaviour without regard for potentially beneficial alternatives. Experimental tests within binary choice models showed the formation of “inertia” (p. 10) displayed by participants; when route factors (e.g. time) were uncertain, previous experience became an extremely influential factor (Bogers, Viti, & Hoogendoorn, 2005). One binary choice experiment compared giving travel time information or no information, and found that delivering information actually reduced utility maximization (Avineri & Prashker, 2006), while another highlighted how people insisted on

‘habitual’ route choice in the face of travel time information (Senk, 2010). Introducing modal choice further complicates rational-choice expectations. A procedure developed by Innocenti, Lattarulo, and Pazienza (2013) had participants choose between two travel mode scenarios: car vs. metro, or car vs. bus. With uncertain travel times, congestion, and cost included in the studies, the authors note that *“travel mode is significantly affected by heuristics and biases leading to robust deviations from rational behaviour”* (p.165, Innocenti et al., 2013). The authors note how participants displayed a preference for cars in opposition to economic benefit which they relate to the affective components of car use, reflecting psychological research on affective influences (Steg, 2005; Steg, Vlek, & Slotegraaf, 2001). Also, Innocenti et al. (2013) discussed how participant’s initial choices strongly predicted their future modal choice, even when presented with evidence that the alternative mode would be more beneficial, highlighting the strong effects of routines upon information searches.

Aside from economists’ utility maximisation studies, an alternate exploration of routine in transportation research was developed by Prato, Bekhor, and Pronello (2012). Using a map of the city of Torino, Italy, with major junctions clearly labelled, the researchers had local participants specify their preferred route from work to home by highlighting labelled junctions. Route choice was analysed for conventional factors (e.g., distance, time, congestion) and compared against several latent variables (e.g., habit, memory ability, time saving skills) using structural equation modelling. Results found that specifying a model that included the latent, psychological variables, significantly improved the explanatory model of route choice than using only utilitarian factors. In particular, Prato et al. (2012) found that habit had a negative relationship with positive route-choice attributes, noting that people with strong habits *“do not tend to search for better alternative routes even if their choice is not optimal”* (p. 316).

### **7.2.3 Exploring routine travel decisions in an open framework**

Noting the lack of knowledge on walking routes to the University found in Chapter 3, and in line with rational choice models, this chapter considered whether providing information may address the problem of route/mode choice. Reviewing the evidence, however, indicates that information provision is often confounded by habitual and routine behaviours, which can mitigate the acceptance of information to change routines, or to adapt existing travel routes. However, commonalities among tasks shown in the literature may limit the application of results. Each study presented participants with variants of two features: a series of choices (e.g., travel routes, investment opportunities) for participants to make, and sets of information (e.g., travel time, expected returns) used to make choices. Combined with these two experimental features are two characteristics, relevancy and labelling, which may influence the applicability of results:

**1. Choices were directly relevant**

Experiments presented options for consideration, such as companies to invest in (Betsch et al., 2001), travel routes to use (Selten et al., 2007), or modes to choose from (Innocenti et al., 2013). These studies did not require any exploration of what options may be used, or which options could be compared: every decision option was provided.

**2. Choices were clearly labelled**

Among the choices available, there was no need for searching where decision choices existed. Routes were highlighted in binary simulations (e.g., Bogers et al., 2005), in open-plan simulations (Prato et al., 2012), and choices in investment-games were clearly defined (Bröder & Schiffer, 2006).

**3. Information was directly relevant**

Information provided always applied to the topic, such as travel time estimates (Avineri & Prashker, 2006), weather situation (Verplanken et al., 1997), or estimated costs or market changes (Betsch et al., 2001). At no point were participants required to assess the validity of information, or search for useful information from an uncertain source.

**4. Information was clearly labelled**

Participants were given the information required in a clear format (e.g., Betsch et al., 1998; Senk, 2010), or could access the required information on request (e.g., Aarts et al., 1997; Betsch et al., 2001). Participants were made aware that this information existed, and the information was clearly identified to participants as a factor within the experiment.

Researchers have an interest in controlling experimental parameters to reduce potential confounds, and by isolating experiment features, the studies described above demonstrated routinisation influences on information use and decision making. By controlling all aspects of the experiments, however, it may be argued that the experiments lack ‘mundane realism’ (Aronson & Carlsmith, 1968) that reflects applicability of the experiment to real-world choices. It is unlikely that a person is faced with a situation, such as route finding or investing, where all information sources and decision options are clearly defined and immediately relevant. Secondly, with the availability of all information and choices provided, previous studies may lack ‘psychological realism’ (Aronson, Wilson, & Akert, 1994), where psychological processes in an experiment reflect real-world processes. People undoubtedly make decisions in experimental and real-world settings, but decision making in an environment of perfect information and choices may miss relevant psychological processes. For example, are all options and information sources registered by a person when not directly



available? Some researchers have challenged laboratory tasks for their overly prescribed environments that prevent application and discovery of an individual's strategies to a problem (J. S. Goodman, Wood, & Hendrickx, 2004; Jurado & Rosselli, 2007), and others have called for more decision-making tasks open to varied behavioural options (Baumeister, Vohs, & Funder, 2010).

In response to the fixed frameworks of previous studies, an alternative experimental approach may be undertaken. Instead of delivering all options and information to participants, an open-world game could allow participants to find and apply the information they personally deem relevant to solve a task. Without explicit labels, an exploration-focused approach could determine, in more natural way, how routines may influence the use and application of relevant information. Inspired by the discussion of travel routes in the Chapter 3 Focus Groups, this chapter outlines an experiment that encourages participants to consider a series of routes across a map and apply relevant information. The exploration-based game, discussed in more detail in the Method section below, included a potential shortcut which may be used when considering routes for a bicycle, but not used when considering routes for a car. As suggested in the opening quote, car users may not perceive walking routes, which may be influenced by routine use of the car, and the goal of this study was to establish whether this blinding effect could be induced in an controlled test. To establish whether routines influence the utilisation of alternative routes for other mode choices, some participants will plot routes for the car before using the bicycle. The hypothesis is that using the car will develop a routine strategy of using roads, which will reduce the use of available shortcuts when using the bicycle. Furthermore, the study will include three conditions that vary the amount of car use prior to the bicycle, with the hypothesis that with increased use of the car (developing a stronger routine), will be linked to reduced use of the shortcut.

### **7.3 Method**

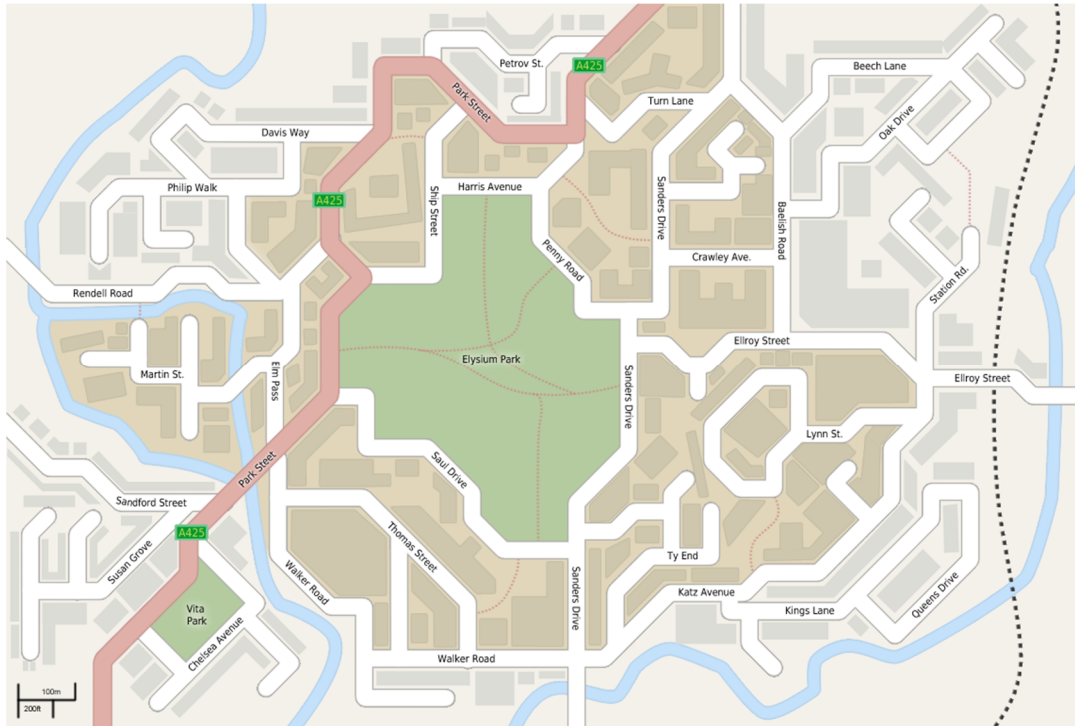
The experiment used an interactive computer game that required participants to plot several routes across a map that contained a variety of possible route choices. For the dependent variable, the map also included a large central park that offered a direct shortcut for each route the participants were required to complete. To establish routine effects, two travel modes were simulated: a 'car' avatar that could only use roads, and a 'bicycle' avatar that could use roads as well as the central park (without explicit instruction). The concept of the study was to evaluate which participants could utilise the park shortcut when available, without explicitly stating the choices or information available.

### 7.3.1 Creation of the Game Map

Designing the map for participants to use was considered in some detail. Initially it was conceived as a simple 'grid' map consisting of a 3x3 square of intersecting roads with a large park area in the centre for bicyclists. Though a basic structure that could clearly demonstrate an inability to deviate from previous routines, such systematic road planning may not represent a realistic journey people might undertake. This is not to mention the fact that a simple grid would make a route-finding task trivial after only a small number of trials.

To increase complexity in a more naturalistic way, inspiration for the map design was sought from existing towns and cities within the UK. Focus was placed upon older locations with street designs that had developed organically over time to create a less predictable format that would require more planning. Several locations were considered, including cities of Bath, Bristol, York, Exeter and Canterbury. Ultimately the city of Oxford was selected as the main source of inspiration; a small city with a dense network of non-linear roads and additional rivers, it combined several factors needed for a believable map of a town. Using the online mapping tool OpenStreetMap, images of Oxford's layout were taken and vertically mirror 'flipped' to avoid any immediate recognition of the layout that may influence participants.

Using the main roads of the city (such as 'A' roads and double carriageways) the map was divided into a number of areas. The centre of the map was allocated to be the central park of the map, and surrounding areas used existing roads as a guide for paths in the map. Roads were simplified to run at 45° angles for ease of control. After roads were designed, additional footpaths were created to illustrate access to the central park for bicycle users. Park entrances were designed away from corners, where people may accidentally gain access to the park. The edited map was rendered using the colour scheme of OpenStreetMap to give the impression of an actual town map. The final map is shown in Figure 23.

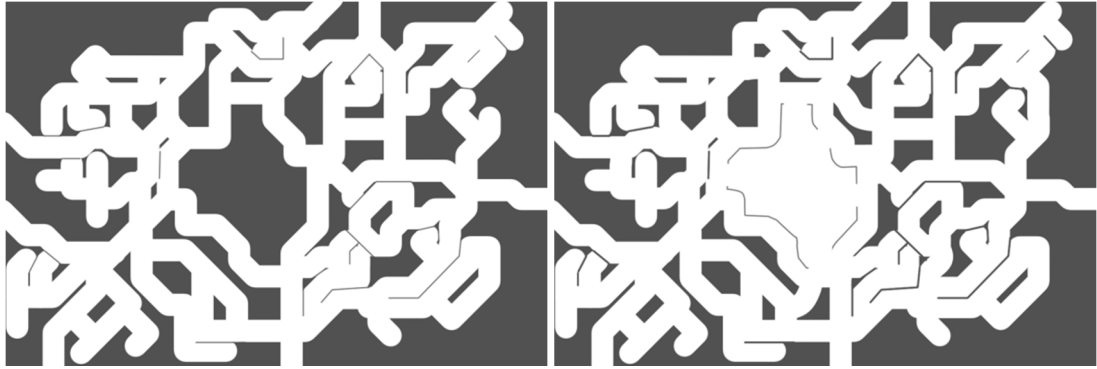


**Figure 23: Map of the fictional town of ‘Argleton’ used by participants to plot routes within the routinisation game. Note the park in the centre with path access points.**

### 7.3.2 Programming & Game Mechanics

The “Games Factory 2” (Lionet & Lamoureux, 2011) game-design software package was used to create game mechanics and structure. The game resolution was set at 1145x768 pixels to fit proportions of standard screens, and appear large enough for participants to clearly see. Visible ‘avatars’ were designed for participants to control, guided by the arrow keys on a keyboard with 45° rotation capability. Controls used absolute direction: when the left arrow was pressed, the avatar would move left regardless of its previous direction (opposed to avatar-centric controls, where pressing the left key would always direct the avatar to its relative left). Movement speed was set at 1.88 pixels per second, a moderate speed allowing reasonable control over movement. The two modes were chosen since both a car and bicycle could be reasonably simulated at the same speed: for example, a ‘walking’ avatar may break game immersion by travelling at the same speed as a car. All avatars were set at 30 pixels in length, the ‘car’ set at 15 pixels width and the ‘bicycle’ set at 11 pixels width.

Maps were loaded into the program as background objects, with ‘barriers’ added that restricted movement of the avatars to the appropriate paths. Firstly, the car avatar was programmed to be allowed along the ‘roads’ of the map. Roads were designed at 25 pixel width appearance, but with 40 pixel width movement allowance set, allowing some flexibility in navigation. The bicycle avatar was allowed to use the roads, but was also granted access to the entrances to the central park, and allowed free roam within the park. Illustrations of the barriers for each avatar are shown in Figure 24.

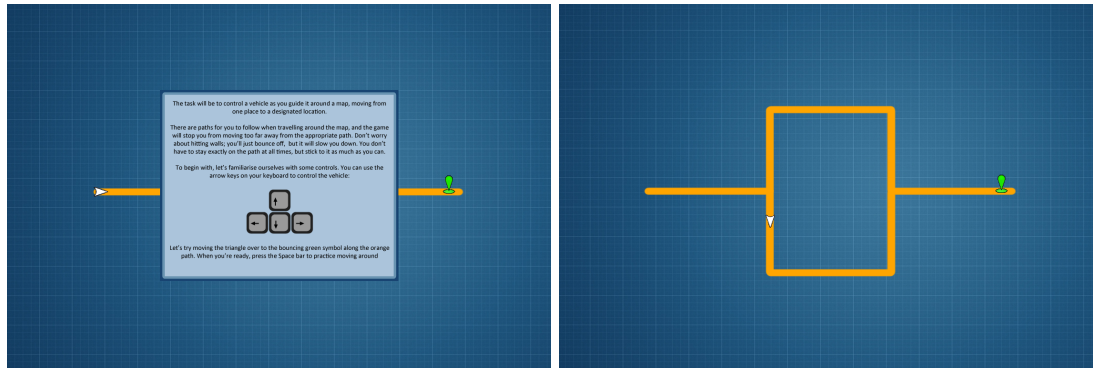


**Figure 24: Illustration of 'barriers' in routinisation game, the white space indicates where participants could travel when using the car (Left) or using the bicycle (Right). Note the inclusion of the park and footpaths for bicyclists.**

The game was programmed to measure two variables: time taken to reach the end destination, and whether participants used the central park. Time spent on each trial, from start to completion (reaching the end goal) was recorded in milliseconds. An additional timer was added for conditions where messages appeared (i.e. when changing avatar) that recorded how long the message appeared. This message timer could be subtracted from the total time to calculate actual time spent on each trial. The second measure, use of the central park as a shortcut, used an invisible 'check' mark that registered if participants travelled through the park when using the bicycle avatar.

### 7.3.3 Pilot testing

Once the custom map had been installed into the program, eight colleagues were invited to use the program to guide a vehicle around the map. Feedback from this pilot testing indicated an issue which had not been considered: not all participants were familiar with computer games. In response, a tutorial was designed and installed before the actual test would begin. The tutorial introduced participants to game controls using the arrow keys, where to direct their avatars, and how barriers would prevent them from moving vehicles away from appropriate paths. The tutorial was designed to be separate from the main task, using a different colour scheme, new avatar (a non-descript white arrow), and map design. The tutorial retained the same 'end goal' indicator as the experimental study to familiarise participants with the objective. Illustrations of the tutorial are highlighted below in Figure 25.



**Figure 25: Illustration of the routinisation game tutorial, including instructions on how to move a vehicle using the keyboard (left), followed by a basic demonstration of moving towards the animated goal icon (right)**

Additional edits made during the pilot testing phase included time guards to stop people from moving too quickly through instructions, creating an animated figure to emphasise the destination point, and creating an animated cursor to highlight the avatar's starting position at the beginning of each trial.

### 7.3.4 Game Procedure

The final procedure for the game opened with a screen informing participants of the nature of the study and reiterating ethical details of consent and the right to withdraw. Once participants confirmed they were willing to take part, demographic details were collected (age, gender, country of origin). A 4-stage tutorial was then completed, firstly moving in a square shape (as seen in Figure 25), then learning diagonal ( $45^\circ$ ) controls, then a third exercise of  $90^\circ$  and  $45^\circ$  paths. The fourth-tutorial stage had participants complete a small section of the full map (while the rest was obscured) before being presented with the full map, described as a map of the town of 'Argleton'. An information box then appeared outlining the legend of the map (highlighting rivers, roads, park space, paths, buildings and the railway line), and participants then informed that the task would be to navigate the map. The information provided at this stage was partly relevant (e.g., highlighting the park and paths), while some information was not relevant to the task (e.g., highlighting the river and railway line), leaving participants to select and use information they personally deemed relevant.

Each participant had 20 trials, which involved plotting a route from a start to end point of the map. Each route required movement from one side of the map to the other side, so that each journey involved a moderate level of planning, and would also be an easier journey if it were possible to travel across the park in the centre. To vary the routes of each trial, eight compass directions were labelled and randomly selected using Random.org. For example, the first trial was randomly selected as south-west and so travelled to the north-east, the second trial from the west to the east, and so forth. Once the direction was determined, the vehicle and location were located generally in the area of the determined direction. Of note, the

starting position and destination were not placed immediately next to a ‘footpath’ to avoid highlighting paths to participants.

Participants were randomly assigned to one of three conditions that varied in the number of car/bicycle trips undertaken:

1. 0xCar / 20xBicycle: the baseline condition to determine whether using a bicycle from the start would let the majority of people use the park and shorter routes.
2. 5xCar / 15xBicycle: Echoing Luchins’ (1942) original work on Einstellung, where 5 tasks invoked the psychological effect before a change was introduced: this condition would create a ‘weaker’ routine.
3. 10xCar / 10xBicycle: An even split of car/bicycle tasks to see if ‘stronger’ routine effects were found than other conditions.

For conditions where the travel mode changed to bicycle use, a message appeared at the start of the trial informing participants they would now be using a bicycle, with an illustration of the bicycle avatar they would be using. Once the 20 trials were completed, participants were thanked, and the game program ended. For a demonstration of the game procedure, see Appendix F.

## 7.4 Study 7

### 7.4.1 Ethical Approval

Approval was granted by the University of Bath Department of Psychology ethics committee, Ref: 12-078.

### 7.4.2 Method

Several methods were used to recruit participants, with two largely samples gathered. Firstly, participants were recruited from the University of Bath using advertisements on intranet noticeboards, or undergraduate psychology students as part of course requirements. Participants from the University of Bath completed the game in a laboratory setting, and either received partial course credits (undergraduate students), or no reimbursement.

Secondly, the study was advertised online using the popular news aggregate website Reddit.com, with participants able to download a copy of the game for participation. Using PHP code, when participants clicked on a link to download the game to play, they were randomly assigned to one of three versions of the game as listed above. Online participants played the game on their own computers, before returning by email a copy of the game output file, and in return were sent a link to a debrief of the study’s purpose and invited to email any questions or comments they wished to make. Online recruit methods have become more popular in psychology research, and can offer comparable results to conventional recruitment

methods (Chandler, Paolacci, & Mueller, 2013; J. K. Goodman, Cryder, & Cheema, 2013), and the particular use of Reddit.com has also proven effective (Casler, Bickel, & Hackett, 2013).

### 7.4.3 Participants

In total 128 participants took part in the study: 22 recruited from the University of Bath laboratory sample, and 106 recruited from the internet. The laboratory sample had a mean age of 18.5 (SD = 0.8) with 15 women. The internet sample comprised 106 participants, with a mean age of 24.9 (SD = 7.7) and with 18 women. Reported location of participants from the internet sample was mostly the USA ( $n=51$ ), followed by the UK ( $n=16$ ), Australia ( $n=8$ ) and Canada ( $n=8$ ). The remaining 23 participants were from locations as varied as Japan, Israel, Argentina, Netherlands, Sweden, New Zealand, Bulgaria, Brazil, Croatia, Spain, Bulgaria, Iceland and Slovakia. Overall mean age was 23.8 years old (SD = 7.5) with 33 female participants (26%).

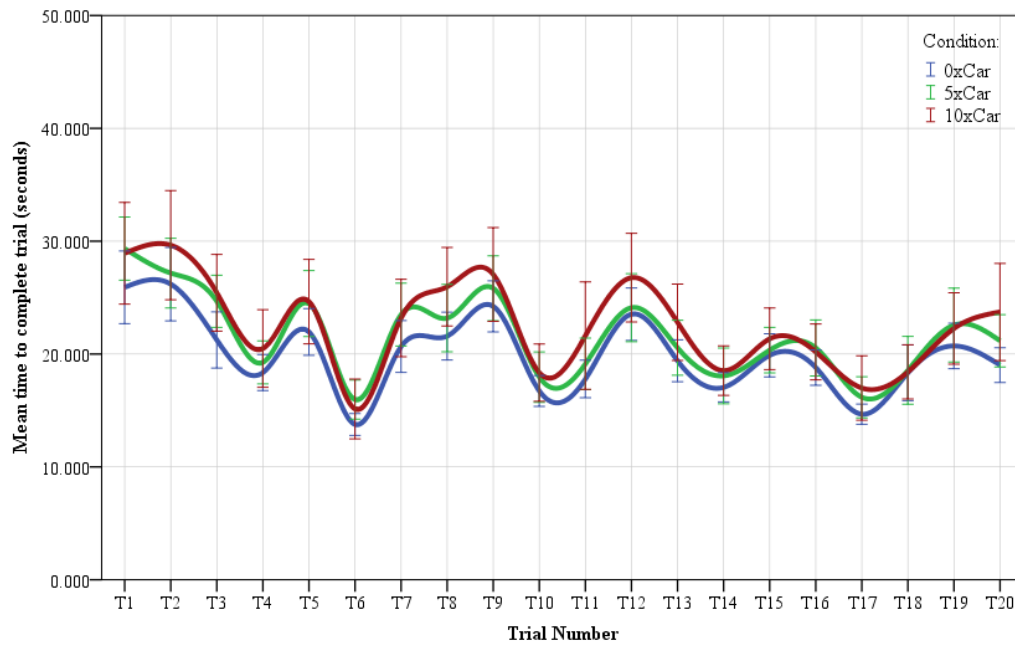
Participants were randomly assigned to conditions: 42 completed the 0xCar game, 46 completed the 5xCar game, and 40 completed the 10xCar game. Demographics for each condition are shown in Table 26:

**Table 25: Participant demographics for the three experimental groups in Study 7**

Group	Age		Female	Stated main mode	
	M	SD		Car	Bicycle
0 x Car	24.24	7.15	8	24	2
5 x Car	23.35	6.87	12	20	7
10 x Car	23.75	8.43	13	15	4

### 7.4.4 Results

No differences were observed between laboratory and online samples' results; analysis is therefore reported for the complete set of 128 participants. Average time taken to complete each trial was computed for each condition. In trials where travel mode changed, the time taken to remove the 'change' message was subtracted from overall time, so all times reflect time spent considering and completing each trial. Two outliers were removed: a time of 257 seconds for a 0xCar participant in Trial 12, and a time of 412 seconds for a 5xCar participant in Trial 19. Recorded times are illustrated in Figure 26.



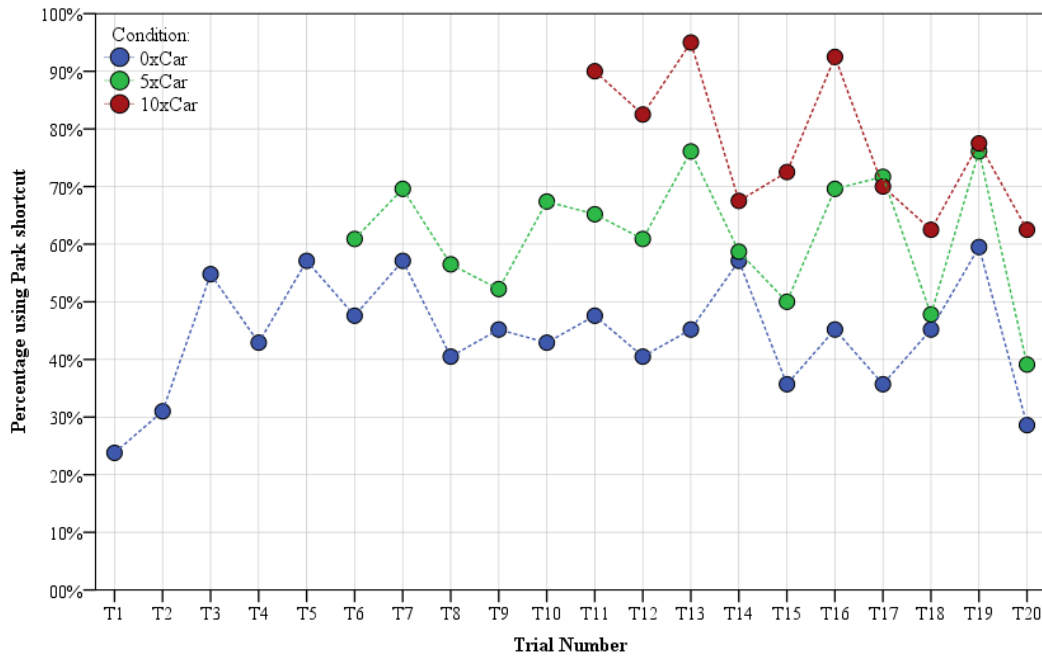
**Figure 26: Mean time taken to complete each of the 20 trials for each condition in Study 7. 95% CI shown by error bars.**

MANOVA analysis compared time spent on each of the 20 trials for the three conditions, and found no significant group effects,  $F(40, 202) = 1.06$ ,  $p = .202$ , Pillai's Trace ( $V$ ) = .386, indicating that participants across the three conditions did not take significantly longer to complete each of the trials.

Time taken to review messages informing participants of the change from car to bicycle was compared for the 5xCar ( $M = 12.7$  seconds,  $SD = 6.9$ ) and 10xCar (15.8 seconds,  $SD = 23.8$ ) conditions, with no significant difference found,  $t(84) = 0.838$ ,  $p = .405$ . The large variance in the 10xCar was due to one outlier of 159 seconds; removing this case led to more comparable times for the 10xCar condition ( $M = 12.1$  seconds,  $SD = 4.9$ ), again with no significant difference found,  $t(84) = 0.461$ ,  $p = .646$ .

The proportion of users in each condition using the park for each of the trials was calculated, with results presented in Figure 27. For the control group (0xCar) 20 trials were able to use the bicycle and thus use the park. For the first experimental group (5xCar) 15 trials were free to use the park and the second experimental group (10xCar) 10 trials opened the park for use. Figure 27 shows that the 0xCar condition appears to have the lowest overall use of the park shortcut, with an increase in use of the park shown by the 5xCar condition, while the 10xCar condition appears to have the highest use of the park shortcut.





**Figure 27: Proportion of participants for each condition who used the park where available in Study 7**

A Generalised Linear Model (GLM) approach using a Binomial distribution and Logit function was specified. For each of the 20 trials for the three groups, the total number of times the park was used (when possible) was specified against the total number of possible attempts, creating a proportion outcome for analysis. To compare regression slopes between experimental conditions, the GLM included the trial number as a covariate, and no intercept was requested. Analysis indicated a significant model fit, Likelihood Ratio  $X^2(3) = 178.66$ ,  $p < .001$ , and the test of model effects indicated that the groups were significantly different, Wald  $X^2(3) = 157.05$ ,  $p < .001$ . Parameter estimates of the three groups were significantly different, shown in Table 27.

**Table 26: Study 7 parameter estimates for the three conditions. \*\*\* =  $p < .001$**

Group	B	Std. Error	95% CI	df	Wald Chi-Square
0xCar	-0.283	0.069	[-0.419, -0.146]	1	16.47***
5xCar	0.466	0.078	[0.313, 0.620]	1	35.53***
10xCar	1.222	0.119	[0.989, 1.456]	1	105.06***

For a more accessible interpretation of results, the total proportions of park-use were calculated for each of the conditions, shown in Table 28.

**Table 27: Study 7 total number of trials, for each group, where the park was used and available**

Group	# Trials that used the park		% Yes
	Yes	No	
0xCar	361	479	43.0%
5xCar	424	266	61.4%
10xCar	309	91	77.3%

Proportions of using/not using the park shortcut were then calculated for the Odds Ratio: an effect size illustrating the change in odds of using the park shortcut when comparing group performance. Odds ratios are shown in Table 29.

**Table 28: Study 7 calculated Odds Ratio of using park shortcut for each group, with 95% CI shown.**

Group	Baseline	
	0xCar	5xCar
5xCar	2.15 [1.72, 2.59]	
10xCar	4.51 [3.44, 5.91]	2.13 [1.61, 2.82]

Results show that when compared against the baseline 0xCar condition, the likelihood of using the park shortcut increased after using the car five times, with an even greater likelihood of using park after using the car for 10 trials.

#### 7.4.5 Study 7 Discussion

Results were surprising; the bicycle-only condition showed a consistently low rate of using the park shortcut, and the more the car was used before the bicycle was introduced, the greater the use of the shortcut. Analysis of the time taken to complete the tasks also indicated that groups did not systematically differ in the time taken to complete the tasks, and with no difference in consideration of the change from car to bicycle for the 5xCar or 10xCar group. Increased time taken to make a decision or review the change may imply greater levels of conscious processing of information (Betsch et al., 1998), but no evidence of such effects was found. It appears that while additional cognition time was not required, the change in context from car to bicycle led incrementally more participants to capitalise on available information (bicycles can use the park) and review their strategy selection (use the park).

### 7.5 Study 8

Study 7 showed that people guiding a bicycle avatar around a city map were more likely to use a park as a shortcut if they had previously guided a car avatar around the map for five trials, and were even more likely to take the shortcut with the bicycle avatar if they had previously guided the car for 10 trials. Considering results from Study 7, the lack of bicyclists in the control group (0xCar condition) was noted. Of the 42 participants in the control group, only 2 stated their main travel mode as bicycle, with the majority reporting car use; a similar pattern of minority bicyclists was found in the 5xCar and 10xCar groups. It is possible that real-world experience may influence the results of the study, and how people considered the information and game scenario.

The influence of past experience in routinisation studies has received limited attention, though some researchers have attempted to control for possible influence by inventing fantastical game scenarios, such as purchasing city-building robots on the moon

(Betsch et al., 2001). When exploring the role of Einstellung effects on experienced chess players, Bilalić et al. (2008a) observed that Grand Masters were less prone to Einstellung when solving problems than the lower ranked (but still very proficient) Masters. An additional study on Einstellung effects indicated that greater chess experience may not completely shield a person from difficulty in routine tasks, but did offer greater resilience to such effects (Bilalić et al., 2008b). The participants in Study 7 likely had prior experience with route-finding, but may have had limited experience with using a bicycle. Although the research by Bilalić and colleagues (2008a, 2008b) examined the highly skilled chess masters and grand masters, the current investigation assumes that a more common experience may influence results – the use of bicycles to travel.

### **7.5.1 Method**

To evaluate real-world experience effects, Study 8 replicated the method of Study 7, except that participants only used the control group (0xCar) condition, with no change in travel mode. The procedure was otherwise identical to Study 7.

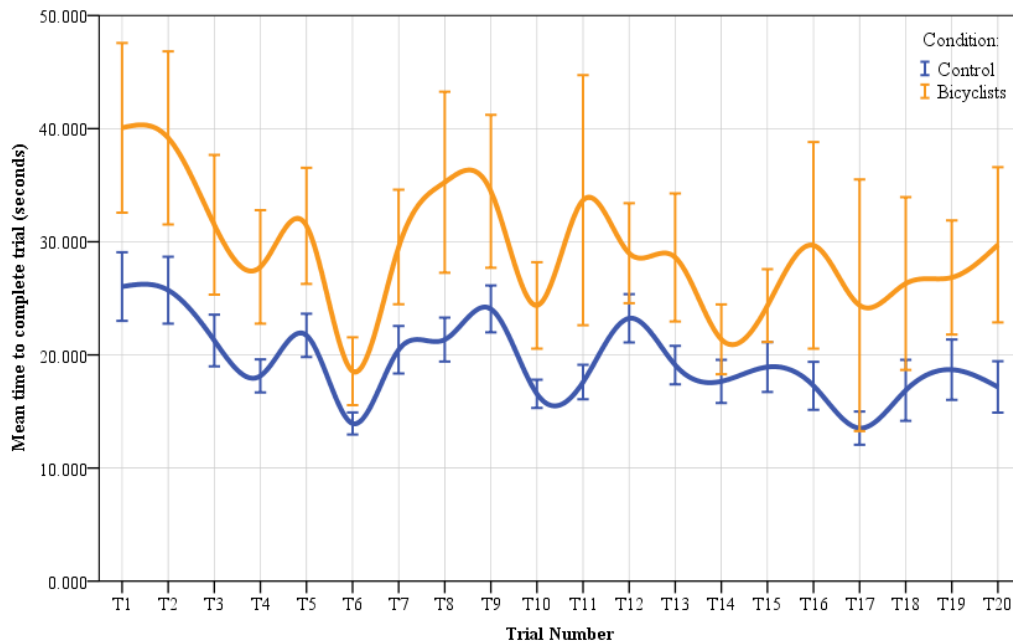
### **7.5.2 Participants**

Using online social media tool ‘Twitter’, the study was advertised to regular bicyclists who likely have a far higher experience of using a bicycle than non-bicyclists, and may be more likely to spot the available paths to them. Using the Twitter account of Dr Ian Walker (with a large following of bicycling aficionados) the study was advertised with a link that led to only the control condition game to download, with game output including a unique identifier to highlight participants sought from the Twitter link

In total the Twitter recruitment method attracted 29 participants who self-identified as being regular bicyclists, with a mean age of 38.2 (SD = 9), and with 6 female participants. The new bicyclist sample completed the 0xCar condition with results compared against the previous control group (0xCar) participants ( $n = 41$ , mean age = 24.2, SD = 7.2, 8 females).

### **7.5.3 Results**

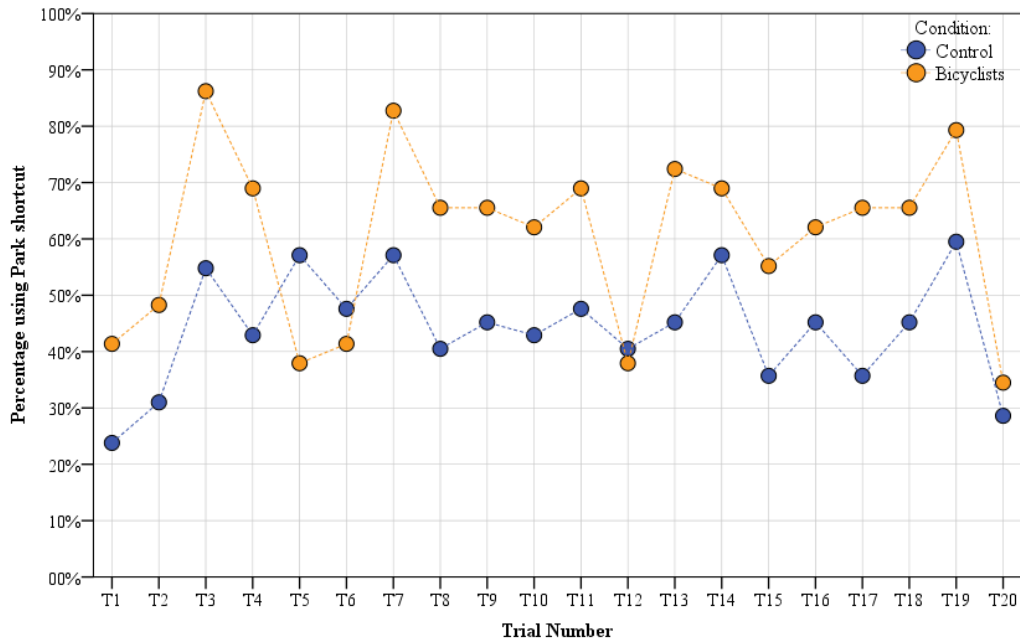
As in Study 7, the mean time taken to complete each trial was calculated for each condition. One outlier of 359 seconds for a bicyclist participant on Trial 10 was removed. Results are highlighted in Figure 28.



**Figure 28: Mean time taken to complete each of the 20 trials for each condition in Study 8. 95% CI shown by error bars**

Using MANOVA analysis, a significant group effect was found when comparing time taken to complete each trial,  $F(20, 48) = 2.296$ ,  $p = .010$ ,  $V = .489$ , indicating that the bicyclists' group generally took more time than the control group. Follow-up tests of between subjects effects indicated significant differences between groups on each trial ( $p < .05$ ), with effect sizes ranging from Partial  $\eta^2 = .07$  for Trial 14, indicating a moderate effect size, up to Partial  $\eta^2 = .24$  for Trial 10, suggesting a large effect size. The full details of individual comparisons can be found in Appendix G.

Comparison of park-shortcut use on each trial for the cyclists and control group is illustrated in Figure 29. It appears that the regular bicyclists were generally more likely to use the park shortcut than the previous control group, with only a small number of regular bicyclists.



**Figure 29: Comparison of original 0xCar control group and new sample of regular cyclists completing the 0xCar condition in Study 8**

As in Study 7, a GLM approach was used to analyse results using identical settings, and a significant model fit was achieved, Likelihood ratio  $X^2(2) = 42.49$ ,  $p < .001$ , with a significant group effects found, Wald  $X^2(2) = 41.74$ ,  $p < .001$ . Individual group effects are highlighted in Table 30.

**Table 29: Study 8 parameter estimates for the two conditions. \*\*\* =  $p < .001$**

Group	B	Std. Error	95% CI	df	Wald Chi-Square
Control	-0.283	0.069	[-0.419, -0.146]	1	16.47***
Bicyclists	0.427	0.085	[0.261, 0.594]	1	25.28***

For interpretation, the total number of successful uses of the park, with calculated proportion of all possible use of the park, is shown in Table 31.

**Table 30: Study 8 total number of trials, for each group, where the park was used**

Group	# Trials that used the park		% Yes
	Yes	No	
Control	361	479	43.0%
Bicyclists	351	229	60.5%

Calculated odds ratio between the control and bicyclists group show that the bicyclist's odds of using the park shortcut were 2.03 times higher than the control group (95% CI: 1.64, 2.52).

## 7.6 General Discussion

In an interactive game, participants planned 20 different routes through an open-world map without feedback or additional information on their performance or options. In Study 7, participants were randomly assigned to one of three groups: using a 'bicycle' for all 20 trips, using a 'car' for 5 trips and then a 'bicycle' for 15, or using a 'car' for 10 trips then a 'bicycle'

for 10. The dependent variable was whether participants took the option, when planning routes on a bicycle, to use a shortcut through a park in the centre of the map (an option not permitted when using the car). As shown in Figure 23, the park was large, forcing routes from one side of the city to another to be longer when only roads were used. For participants who only used the bicycle to complete the game only 43% used the park shortcut, while the odds of using the park were 2.15 times higher after using the car 5 times (averaging 64.1% using the park), and odds of park use further increased to 4.51 times higher after using the car 10 times (an average of 77.3%). The results indicate that the greater the experience participants had using the car avatar, the greater the likelihood they would use the shortcut when they started using the bicycle avatar.

To evaluate whether prior real-world experience was linked to task performance, Study 8 sought a sample of regular bicyclists who took part in the bicycle-only condition. Compared to the Study 8 bicycle-only group, who were mostly non-bicyclists in the real world and who used the park on 43% of trials, odds of the regular bicyclists using the park were 2.03 times higher with an average of 60.5%, with no tendency for either group to become more or less likely to use the park as the experiment progressed. The lack of any trend over time suggests people did not, on each trial, have some probability of experiencing an ‘aha’ moment, noticing the shortcut opportunity and from that point on sticking with this more optimal strategy. The greater use of the park in the real-world bicyclist group suggests that the task had some validity as an analogue to real route-finding. It also suggests that people do indeed use prior knowledge in laboratory decision studies no matter how ‘gameified’, and therefore, studies such as Betsch et al. (2001) were right to consider this.

### **7.6.1 The surprising influence of context change upon routine strategy**

Ultimately, the initial hypothesis was not supported; increased use of the car did not lead to a lower park-use strategy when plotting bicycle routes. Results were quite the opposite, after changing the context of the task (moving from using a car to using a bicycle) people were more likely to use the park as a shortcut than if they had started on the bicycle. Context change influences on routine choice were discussed briefly in the introduction of this chapter, though it initially appeared that the results would not be strong enough to influence the current study. Only two studies demonstrated a significant effect of context change on breaking routines and both used a simple choice mechanism in a highly controlled task with clearly labelled options and information (Betsch et al., 1999; Betsch et al., 2001). A more detailed investigation exploring routine strategy use found that context changes, even when made highly explicit for participants, did not alter routine strategies (Bröder & Schiffer, 2006). As the use of the park depended on participants registering the available information (bicycles can travel through the park), and then applying this knowledge (the park offers a

shortcut), use of the shortcut can be defined as a strategy, following the definition by Bröder and Schiffer (2006). As the current study did not explicitly highlight options or relevant information, and implemented a routine strategy method instead of clearly defined and limited options, it was believed that the influence of a routinised car use strategy would be the predominant effect.

The results do however support the previous work that demonstrates the influence of context change to reduce routine choice (Betsch et al., 1998), and that increasing a routine strength is linked to greater deviation from previous routines after a context change (Betsch et al., 2001). The current study is also the first example (that I am aware of) to compare three conditions of increasing routine strength rather than a binary yes/no routine manipulation. The increasing relationship between the amount of car experience and the size of the behavioural shift upon moving to the bicycle supports previous evidence that contextual change, coupled with the strength of previous routines, increases consideration of available information (Betsch et al., 1998, 2001) and extends this to routine strategy. As the change from car to bicycle gave no explicit information to participants about the availability of new routes, the increased use of the bicycle within the park likely stemmed from considering the appropriateness of the bicycle and how to apply the new information. Study 8 clarified this, indicating that previous experience of bicycling was linked to greater ability to apply the use of the bicycle as appropriate for using the park. The fact there was a substantial difference between the 5xCar and 10xCar conditions might even provide clues about the time-course of routinisation, at least for this task.

### **7.6.2 Application of results to socio-cognitive theories**

The results may have applications for cognitive theories on routinization, and the use of information in strategy and choice selection. The Strategy Selection Theory (SSL) proposed by Rieskamp and Otto (2006) states that experience of a strategy outcome defines the learning and use of strategies to solve problems, and that a failure or loss outcome is required to learn and change strategy (Rieskamp, 2008). An alternative approach, suggested by Betsch et al. (2001) and Bröder and Schiffer (2006), applies dual-process theories to routine in decision making, with a detailed application presented by Betsch and Held (2012) describing the 'RUN' and 'JUMP' model of processing. Their model proposes that once a routine is learnt, RUN processing (where automatic Type 1 processes quickly guide behaviour) is engaged, with only limited use of controlled and reflective Type 2 processes, and with no consideration of alternative strategies. The RUN processing continues, and only when the applied routine or method fails is JUMP processing engaged (Betsch & Held, 2012, p. 77): at these times of difficulty the full engagement of Type 2 processes are used to consider an alternative strategy, and in effect, 'JUMP' to a new strategy for use then in the default 'RUN' processing. One

implication of this theory for the current study is that, although clear differences in strategy were seen between groups, it was not possible to fail any of the trials – there were no negative outcomes for speed, route taken or any other factor. The only change was the strength of a strategy beforehand and the change in context. The fact that context change was sufficient to spur the use of different strategies would suggest that there are alternative methods of making people reconsider their strategies, besides negative outcomes or failures from the current routine.

A broader theory of dual-process cognition proposed by Stanovich (2011) separates controlled Type 2 process into two ‘minds’: the *algorithmic mind*, which applies strategy, and the *reflective mind*, which creates new strategy. Termed the tri-process model, of interest here is the concept of a ‘Serial Associative Cognition’ where the algorithmic mind applies a strategy that is locked into the contextual frame of the topic at hand, and cannot consider alternative strategies. In the current study, when the context change occurred, the tri-process model explains the shift in strategy as a form of ‘decoupling’ that led to the reflective mind considering new information, simulating the scenario, and choosing a more appropriate strategy (i.e., using the shortcut now available). Additionally, the algorithmic mind contains previously used strategies (Stanovich, 2011), which would explain how the bicyclist sample in Study 8 were more likely to use the shortcut, as the context of the bicycle engaged previous strategies. The tri-process model is an intriguing concept that could explain why context change, without failure or negative consequences, would lead to a change in strategy. However, a complication is the inconsistency in strategy used by participants. Though groups used significantly different strategies, individuals weren’t stable in their use of the park – some never used, or consistently used the shortcut, but often participants would use, ignore, and then reuse the shortcut. This suggests using the shortcut is not an insight problem that requires a flash of inspiration to solve (Jung-Beeman et al., 2004), but rather being aware that the shortcut is available means it is given more ‘weight’ in decision making after a context change, and therefore is used more often. Decoupling may be taking place, and with increasing force after stronger repetitions are broken, though it is unclear how participants in the condition without context change used the shortcut and then ignored it. Future research may employ time constraints to increase motivation to obtain the fastest route (presumably increasing use of the shortcut when found), or employ think-aloud protocols when completing the task to record thought processes. Previous work on routine choice and strategy indicates that creation and use of routines is influenced by time constraints. Forcing participants to make quicker decisions leads to increased reliance on previous routines (Betsch et al., 1999; Betsch et al., 2004), and while participants were instructed to select the quickest route in the current study, there were no punishments, constraints, or reminders of time taken. Given



previous findings, it is predicted that the addition of time constraints would increase the divide in use of the shortcut between groups, as exploration becomes less important than maintaining a previous choice. The exploration method could investigate this in different ways; giving participants a strict time limit to complete the trial, or simply showing a clock recording the time taken for a trial, and whether these lead to variations in maintaining previous routines.

The results may also be applied to habit theory, and how information acquisition may vary with habit strength. Though after less than 20 trials it may not be claimed that habits (as automatic and context-cued responses with reduced information requirements) were formed, the sizeable differences between groups indicates that a change in task context led to greater use of available information (the bicycle can use the park). Previous work has shown that people showing habitual behaviours require less information to make behavioural selections (Aarts et al., 1997; Verplanken et al., 1997). A key point in habitual behaviours is the reliance on contextual cues for activation of the behaviours (Wood & Neal, 2007), which means breaking context reduces the effects of habit, allowing for more consideration when determining behaviour – as demonstrated by Verplanken et al. (2008) for people who had recently moved home. The use of breaking contexts to reduce habit strength and facilitate information absorption has been previously recommended (Chorus et al., 2006), and results presented here would support the delivery of behaviour change information at times of context change (e.g. house relocation, new job) to increase consideration. In an intervention that promoted sustainable travel after a house-relocation, a “sensitive phase” was described where information was more accepted (Bamberg, 2006, p. 832): a finding the current study would also support. Additionally, an intervention to reduce habit strength, by using personal norms to promote conscious consideration, suggests that car reduction occurred when participants with strong habits became aware of alternative travel modes (Eriksson, Garvill, & Nordlund, 2008). The current study demonstrates a striking similar phenomenon: information use and consideration of alternative routes was enhanced after context change. This suggests that breaking habits, in line with habit discontinuity (Verplanken et al., 2008), is an ideal time for promoting information and awareness of alternative options. Further work is needed, however, to evaluate the effect of more established habits and to see whether there are common mechanisms at work between the short-term routinized behaviours studied here and longer-term habitual behaviours. Lally, van Jaarsveld, Potts, and Wardle (2010) recorded habit strength for repeated behaviours over time to monitor formation of habit, and the current methodology may be employed on a similar basis. If participants were to complete a route-finding trial on a daily basis for days or weeks, it may be possible to examine how the

strategy develops into a possible habit, and the effect of habit discontinuity at different points of habit strength.

### **7.6.3 Evaluating the use of a new and open-world exploration method**

This chapter presents a new experimental method for investigating routinisation effects upon information utilisation. Instead of providing participants with all the required options and delivering prerequisite information, participants were given some basic information and allowed to formulate their own strategies, using information they deemed relevant, to complete the given task. The development of an open approach is supported by several authors who have challenged psychology tasks that restrict applications of individual choice. Reviewing executive functioning research, Jurado and Rosselli (2007) highlighted how tasks may not capture true aspects of cognition, as “the examiner is the one usually determining when and how the task must be executed without leaving the patients sufficient leeway to analyse and choose alternatives for the completion of the task” (p. 219). Allowing participants to actively engage with the task choices, such as a route-finding task, may develop a range of novel findings. Alongside the critique of experiments that lack an exploration of choices, Goodman et al. (2004) highlight how extensive information and feedback “does the work for performers, making it seemingly unnecessary for them to engage in the exploration, information-processing, and recall activities essential for learning” (p. 249). Previous studies have taken great care to control the choices and information available to participants in order to isolate and create routine effects. If, however, routinisation studies are to explore the learning and implications of routine decisions or strategies, exploration and information processing should be promoted within task designs for a more nuanced view of routine influences. But even with the benefits of an open-world framework, as used in the current study, there is a risk that results are not entirely reflective of the formed routine and its influences. The term “task impurity” from executive functioning research highlights the difficulty in isolating specific cognitive process from the multitude of different processes required to complete a task (H. R. Snyder, 2013). The current investigation highlighted how formed routines improved use of a shortcut after a context change, but also how past experience had an influence on the use of the shortcut. Additional research is needed to understand the processes involved with the open-world method, possible by comparing exploration-based results with constraint-methods used in conventional routinisation studies.

Even with the open-world framework used, the study design was extremely simple: the game objective was clear, only one dependent variable was used, feedback was not required, behaviour was not rewarded, and participants had no financial incentives. This is compared to the complexity of routine decision-games such as stock market games (Bröder & Schiffer, 2006) or investment options (Betsch et al., 2001) that employ a broad mix of

incentives, information, and decision choices. With a binary outcome of using the park or not, the current results show a clear influence of routines and past experience. Other investigations also found that imposing short time limits on decision options increased the use and strength of routines, while more relaxed time limits indicated lower routine use (Betsch et al., 1998; Betsch et al., 2004). Even without any form of time constraint, the current results demonstrated clear routine effects. Additionally, only 20 trials were used for evaluation, and with only 5 trials demonstrating a routine effect for some participants. Routine studies vary in their level of repetitions – some use trials involving up to 80 trials to develop a habit (Bröder & Schiffer, 2006), while others have shown habitual patterns from 32 trials (Betsch et al., 1999), 15 trials (Betsch et al., 2001), and 5 trials in the classic Water Jug problem (Luchins, 1942). Considering that only a small number of game features were used, and the strength of the results found, the open-world method likely reflects a profound psychological effect (Prentice & Miller, 1992).

The minimalist approach to the study design opens up a new range of modifications that, as mentioned earlier, may be required to fully understand routine influences. For example, the role of context change could be adapted for additional scenarios; moving from car (no access) to bicycle (access) led to an increase in park use. But it is unclear what would occur if both modes had access to the shortcut, such as moving from a pedestrian to bicycle, or vice-versa. If context change is the key to increasing information use, then the pattern of incremental shortcut use should remain, but as shown in Study 8, past experience is an influence, and people likely have more experience walking than bicycling which could influence results. To isolate the influence of past experience, the method could attempt to emulate Betsch et al.'s (2001) moon base simulation, and develop a game free of personal experience. Perhaps using a series of abstract shapes, it may be possible to 'teach' participants some internal game logic that can be applied to reach more optimal solutions, much like the connection between 'bicycle' and 'park' was dependent on previous knowledge. The level of routine and knowledge would also have to be explored by the number of trials used to develop routines. Using three conditions of 0, 5, or 10 trials to develop a routine, the incremental effect of context change on routines was shown. More variation is required however, such as varying the level of routine learning, or varying the length of the overall trial for possible routine decay.

Lastly, after completing the task (either online or in the laboratory), several participants expressed satisfaction when completing the computer game task. Capitalising on using games to collect data could be an effective way of engaging participants, especially when hosting games online for accessibility. As with almost any study, more participants would be useful. After noting the potential for variation in the game design, attracting large

participant results using a game approach offers an opportunity to implement a number of changes and evaluate effects. Aside from comments on game satisfaction, future work may also clarify how aware participants were of the game details. Several studies use manipulation checks to record how aware participants were of game choices (Betsch et al., 1999; Betsch et al., 1998; Betsch et al., 2001), and future approaches could use these details to clarify game effects

## **7.7 Conclusions**

Inspired by limited awareness of walking routes shown in the exploratory work in Chapter 3, and noting a possible bias against information interventions because of routines and habit, this chapter describes an investigation into route choice. For a more naturalistic approach, a game was designed that encouraged participants to develop their own strategies to solve a route finding task in an open-world map. Increasing routine of car use was manipulated before using a bicycle that could use a quicker shortcut across the map. The initial hypothesis, that increased car use would be linked to reduced use of the bicycle shortcut, because of a learned routine for car/road use, was not supported. Surprisingly the opposite occurred, and it appears that the context change of car to bicycle allowed greater use of available information. The use of information was evaluated within Study 8, and regular bicyclists were found to have a greater use of the park, without any context change, than the original sample with limited bicycle experience. Results support the use of contextual changes to encourage greater information use, and show the first instance of how routine strategies may be disrupted by change. The open-world method appears to have a lot of potential for future use, but extensive investigations are required to assess the validity of the measure, such as the role of past experience and contextual changes within the game design. Ultimately, it appears that routines can prevent people from spotting all available paths, and disrupting contexts can alleviate this problem.



## Chapter 8: An Action Research account of The Walking Network

“ . . . So what’s all this for then?”

- Zoe, Car Driver (1421)

### 8.1 Abstract

*This chapter, in contrast to the conventional investigative studies described earlier, describes how the previous findings were applied in a community-focused project to encourage sustainable travel behaviour. Noting several logistical issues that prevented a randomised control-trial approach, an alternative and qualitative Action Research approach was used to enact a positive change by promoting sustainable travel. After recognising some of the perceived difficulties with walking and route-finding, a series of convenient and scenic walking routes were designed to encourage walking to the university. In partnership with the local council, and recruiting a design team from a nearby university, the routes became the ‘Walking Network’. Using a mix of online and interactive resources, coupled with physical signs and promotional activities, the Walking Network was launched as a pilot scheme to encourage active travel. The project has received excellent reviews from local stakeholders, and attracted attention from several large employers in the west of England who have expressed strong interest in developing similar projects. This chapter describes the first phase of the Walking Network, with scope for extensions and larger publication of the project that may continue the project as part of future research into sustainable travel mode choice.*

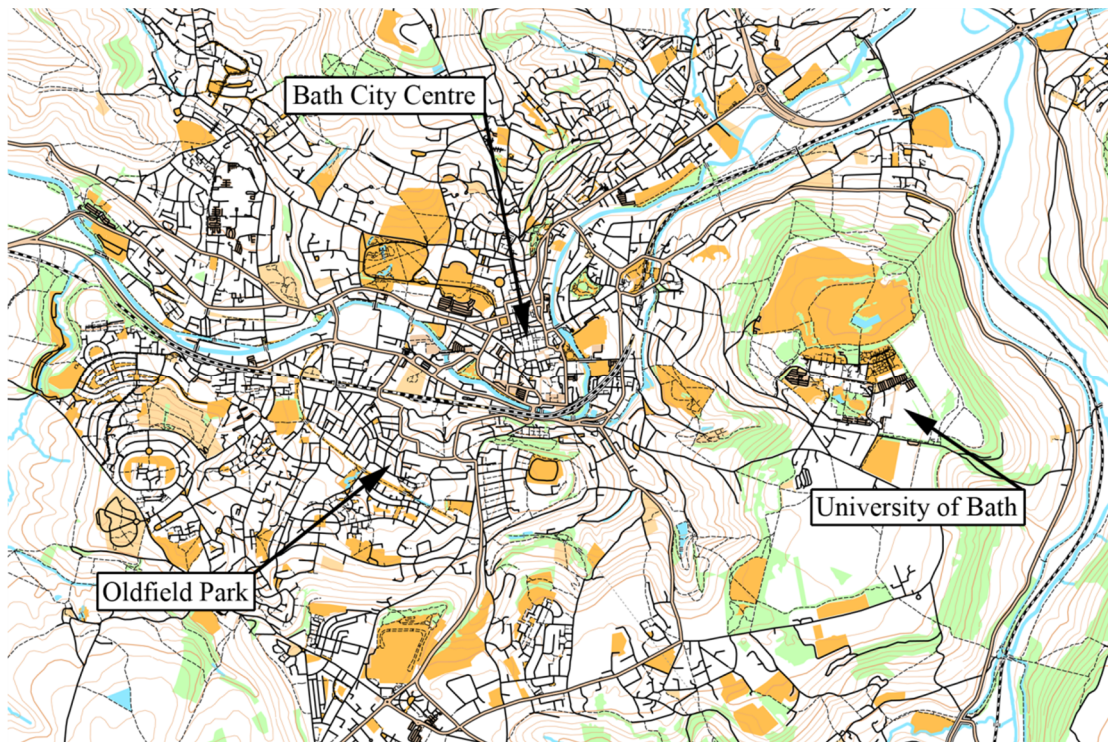
### 8.2 Introduction

Throughout this thesis I have attempted to explore, model, and discover a varied selection of psychological factors involved with travel mode choice. The original intention was to demonstrate how the automatic factors of habit and affect may be involved with choosing and considering means of travel. In addition to the goal of demonstrating automatic influences, this thesis also intended to show how these influences may be applied to promote sustainable travel mode choice. Through chapters 3 to 7, research has explored discussions of modal choice, quantify differences between mode groups, model modal choices, measure how affective links to environmental values may link to modal choice, and simulate routines and habitual influences on modal choice and route selection. This chapter takes a different approach, however, and applies the findings of previous work into an applied project. With a reduced emphasis on scientific evaluation, and instead focused upon enacting a new and beneficial project, this chapter reviews and applies the previous results to demonstrate the

potential for automatic influences to be considered in application: promoting sustainable travel to the University of Bath.

### 8.2.1 Situational Context

The University of Bath is located approximately 1.3 miles (2.1 km) east of Bath city centre, situated on a hill approximately 155 metres above the city centre (Bell, 2013). The context of the hill can best be shown using contour lines, as seen in Figure 30.



**Figure 30: Topography map of Bath, indicating the University of Bath campus and Oldfield Park area. Scale at 1:20000, with 10m contour lines. Map created by O'Brien (2013) using Ordnance Survey and OpenStreetMap.**

Figure 30 shows three main factors for travel: the location of the University of Bath campus east of the city centre, the main area for student accommodation (Oldfield Park) to the west. Most recent figures available indicate that for the 2012/13 academic year, there were 13,040 students studying at the university (i.e. not on placement/gap year), and 2,712 staff employed at the main campus. From the 2012/13 Travel Survey (explored in more depth in Chapter 5), 94.2% of students reported living less than 10 miles from the University of Bath, and 65% of students lived in either Oldfield Park (highlighted in Figure 30) or Bath city centre. The majority of staff also live <10 miles from campus (80.3%), though were fairly evenly spread across the city of Bath. When asked to describe their main travel mode to the university, 64.9% of students used the bus.

### 8.2.2 Designing a method to encourage sustainable travel

The original intention for this chapter was an intervention study with full use of a control and experimental group, with manipulation of information delivered to participants, and recording waking attitudes and behaviour for statistical analysis. Prominent reviews of physical activity interventions have raised a need for control groups and systematic evaluations of outcomes (Ogilvie et al., 2007). As desirable as it is to carry out a large-scale intervention with detailed evaluation and control-group methods, there are several reasons why this was infeasible.

Using the habit discontinuity theory (Verplanken, Walker, Davis, & Jurasek, 2008) the plan was to target students at the University as they moved off campus at the start of their second year. Students at this time move out of campus-based accommodation into the main city, which would present an ideal break in previous habits and would increase their level of information seeking and awareness (Betsch, Haberstroh, Glöckner, Haar, & Fiedler, 2001; see also Chapter 7). The original intention was to randomly assign students within the 2nd year to a control or experimental condition, delivering information, materials and survey evaluations as appropriate. However, since the majority of students move into shared housing (normally between 3 and 8 people), the risk of cross-contamination of experimental groups was high – it would be unreasonable to believe that if one student was contacted in a house of 5, that one student would be willing to walk alone and not speak of the intervention to their housemates.

Attempts to control contamination by separating students by course (e.g. biology from chemistry) would also likely fail since houses and friendship groups aren't constrained by study subject; engineers are friends with sports scientists who are friends with psychologists and so forth. One idea was to use the 4th year students as a control-group. The majority of students on BSc courses leave the University of Bath for a year in industry in their 3rd year of study, returning in their 4th year to complete their courses. However, though the habit-discontinuity theory would apply, a higher level of experience in travelling to the University from private accommodation may confound results, and with final-year projects due, there were ethical issues with recruiting 4th years who would likely be extremely busy. Another idea was to compare the University of Bath with nearby Bath Spa University students as a cohort-control group. However Bath Spa University is situated on the western edge of Bath, a further distance from city than the University of Bath (approx. 3.6 miles), and has limited footpaths leading to the main campus, which again may confound results.

The required timeline for an effective randomised control trial also presented difficulty. Guidelines for interventions state that measurement of behaviour should extend several months (Ogilvie et al., 2007), and with the targeting of returning students in October 2013, with a PhD end-date of March 2014, any measurement length would be limited and further hindered by taking part over winter when active travel modes decline in use (Flynn, Dana, Sears, & Aultman-Hall, 2012). After considering the various logistical problems with a



large-scale intervention study, it was agreed that an alternative direction be taken; a form of Action Research using more qualitative measures for evaluation.

### **8.2.3 Action Research**

Action research was first developed by Kurt Lewin (1946), who felt the divide between academic research and social problems was problematic, and promoted research application. In his own words: “*Research that produces nothing but books will not suffice*” (Lewin, 1946, p.35). Action Research is a philosophy towards research that eschews the primary focus of reports, data, and publications, and instead aims “*to produce practical knowledge that is useful to people in the everyday conduct of their lives*” (Reason & Bradbury, 2008b, p. 4). In a broad sense, Action Research is the step from externally observing a problem, to becoming involved and improving a problem by applying research and theory (McNiff & Whitehead, 2011).

In application, Action Research can be understood as a process of steps and cycles: a series of steps from recognising a problem, working with stakeholders to find a solution, enacting the change, then considering the effect, before re-enacting the cycle to improve the process (Christ, 2010; Lewin, 1946; Maruyama, 2004; Reason & Bradbury, 2008b). The process can also be thought of as an upwards spiral of on-going consideration of actions undertaken, the implications of the actions, and continuing work with stakeholders (i.e. people involved in the problem) to improve the situation. It is this concept of actively engaging with, and consulting the people experiencing the problem to find a solution, that defines Action Research (McNiff & Whitehead, 2011). More often employed using qualitative methods of engagement with groups, Action Research embraces post-modern epistemological views such as constructionism and relativism (Reason & Bradbury, 2008b), although quantitative measures are also used (McNiff & Whitehead, 2011). Indeed, some authors suggest that any social science method is suitable for Action Research, as long as they add to the participatory and problem-solving goal of the project (Greenwood & Levin, 2007). The use of Action Research in a mixed-methods approach is especially valid; Action Research is a pragmatic approach that rejects any incompatibility assumptions about combining qualitative and quantitative work (Christ, 2010).

In a systematic review of 52 reports, Waterman, Tillen, Dickson, and de Konig (2001) reported that reasons for undertaking Action Research were primarily to improve a situation (64%), and to develop and implement a strategy for change (60%). Action Research has been applied to a number of research fields and areas, but predominantly exists in the fields of education (e.g. curriculum design and classroom management) and health research (e.g. interactions between healthcare professionals and patients), though is by no means limited to these areas (Stringer, 2007). As a democratic process of reaching out to those affected by an

issue, Action Research has also been applied as a means of socio-political liberation for oppressed minorities (Reason & Bradbury, 2008b).

Although Action Research has strong links to of social inequality or education, it has been successfully applied to a range of transportation issues. Porter, Blaufuss, and Acheampong (2012) describe their collaborative efforts and implications from increasing bicycle use for women living in remote villages in Ghana; Sterrett, Hackett, and Hill (2012) highlight how spatial and transport planning in Belfast accentuated social divides and chronicled the rise of a local community activist group to encourage improvements; and Preston (2004) documents the benefits of consulting residents in a Leicester borough to improve the quality of public transport when designing a new bus scheme.

With a ‘family’ of different research methods and approaches within Action Research (McNiff & Whitehead, 2011; Reason & Bradbury, 2008b), each application is different. Definitively describing what Action Research ‘is’ cannot be achieved, since it reduces the idea of Action Research to “*a set of procedures to be applied to practice, rather than a living experience*” (McNiff, 2013, p.24). Unlike the conceptually-rigorous application of Grounded Theory detailed in Chapter 3, several authors note that Action Research is a more relaxed affair. Maruyama (2004) argues that even if a researcher doesn’t match the perfect ideals laid out by Lewin (1946), it shouldn’t deter research; positive applications for practice and theory may still develop. Concerns over the ‘correct’ manner of research can prevent application of Action Research to a wide range of issues, and so the focus should remain on full disclosure and discussion of considerations made, with the continuing aim of establishing a helpful project (Reason & Bradbury, 2008b). Ultimately, the practice of application is more important than the preceding theory; certain theoretical tools can be suggested, but they must be adapted to each circumstance (Chambers, 2008).

With the understanding that Action Research can be tailored to different circumstances without the need to conform to fixed parameters, I felt that Action Research could be used to capitalise and apply the results of my previous studies. As a consultative process that seeks to understand the issues people experience with promoting sustainable travel, I argue that my previous studies in this thesis demonstrate a range of consultation methods to understand the problem. Action Research is a method that draws from multiple methods of communication with people (Reason & Bradbury, 2008b), and the combination of qualitative and quantitative methods may be used to guide an Action Research project (Christ, 2010; Stringer, 2007). To understand how my previous studies may be applied, a brief review of their implications for changing behaviour must be addressed.

#### **8.2.4 Learning from Previous Work**

In my first study, described in Chapter 3, Focus Groups were held with users of different

travel modes to understand their views and concerns when faced with changing travel behaviour. Through Grounded Theory analysis, a deep concern for respecting personal autonomy became apparent; changing travel behaviour could be seen as an attack on personal choice, behaviour change should consider and respect a person's choices, and people's current travel mode choice was a source of autonomy that they feared losing. For this last, point, bus users were actually the opposite: with a lack of autonomy over journey time, comfort and predictability, they felt powerless in their regular commute. The importance of autonomy has been suggested several times (Chatterton, Coulter, Musselwhite, Lyons, & Clegg, 2009; Gardner & Abraham, 2007; Steg, 2005), but concern for losing autonomy was a powerful new finding. When considering the current intervention, it became clear that messages should be tailored to promote walking as a source of autonomy, without creating messages to attack choice, but instead highlight the benefits of walking as a hassle-free transport choice. A second finding from the Focus Groups was the low awareness of walking routes to and from the University. For people who commuted by car or bus, there was confusion and uncertainty about how to walk to campus, especially since all they had experience were the main road routes; fairly unpleasant walking routes, but ones that served cars and buses. A result not previously considered, this was the formation of the idea that a map showing fast, scenic and accessible walking routes to the University could have a beneficial impact on sustainable travel behaviour.

Chapter 4 detailed the 2010/11 Travel Survey; exploring results from a range of psychological scales relating to topics covered in the Focus Groups. With three main findings, the first indicated that Environmental Concern did not vary between users of different travel modes. Despite stereotypes of green active travel mode users (Daley & Rissel, 2011; Gatersleben & Haddad, 2010), only minute differences were found, suggesting groups were similar in their views. Secondly, habit strength (the strength of automaticity of behaviour) was stronger in active travel mode users than other groups. As a possible source of explanation, the third result was the overwhelming commute satisfaction reported by active mode users, and the surprisingly neutral opinion from car users (with bus users strongly negative). Taken together, the three results confirmed that walking would be an appropriate behaviour to encourage as an enjoyable activity that lent itself to forming a strong habitual component. The lack of differences in environmental concern informed the message of an intervention; if users of all groups had equally strong environmental attitudes then promoting 'green' motivations would likely have little effect, since it wasn't related to existing travel mode choice.

The exploratory work gave several new directions for research, which were investigated in more detail in the third section of the Thesis, covering Chapters 5, 6 and 7. In

Chapter 5 I attempted to replicate the Comprehensive Action Determination Model (CADM) proposed by Klöckner and Blöbaum (2010). Unfortunately, the ultimate goal of predicted behaviour wasn't possible due to an imbalance in question specificity, but numerous methodological issues with structural equation modelling, and questionable model design by the original authors restricted full interpretation of results. One positive that emerged from Chapter 5 was the measurement and prediction of psychological constructs within the CADM, consisting of well-established models: The Theory of Planned Behaviour (Ajzen, 1991), The Norm Activation Model (Schwartz, 1977; Schwartz & Howard, 1981) and Habit Theory (Verplanken & Orbell, 2003; Wood & Neal, 2007). Multi-group analysis suggested that when considering the link between model constructs (i.e. the influence of Attitudes on Intention in the TPB) there were no significant differences between users of different modes. Similar to the homogeneous environmental concern found in Chapter 4, the absence of different pathways to suggesting that using TPB or NAM principles would have little effect; differences may exist in strength of habit or other concepts, but the links between measures show little difference.

Chapter 6 investigated the lack of difference in environmental concern, and discusses the development of the first implicit measure of environmental values. Considering the differences in opinion and attitude in the focus group work, but similarities using explicit survey scales, a new path of implicit concern was applied to users of active travel mode users (bicyclists or walkers) and car users. Despite promising application when looking at environmentalists and the general population, no differences in implicit concern were found. This further emphasises the choice to avoid environment-based messages to encourage change, but to tackle other messages instead.

Chapter 7 reported a laboratory approach of measuring whether repetition of route-finding strategy 'blinded' people to alternative routes; inspired by the lack of awareness of walking routes shown by car and bus users in Chapter 3. Using a customised 'game' methodology, participants planned routes around a town map, piloting a car then a bicycle in different proportions for a total of 20 trips. Results were the opposite of my original hypothesis and most surprising finding in my investigations; after increasing the strength of a car-use routine, performance in using an available short-cut when using a bicycle significantly improved. Though an artificial approach to a real problem, Chapter 7 illustrated the importance of breaking previous routines in order for people to willingly change their previous tactics and try new approaches.

Considering the range of results, there were three clear concepts, which taken together, could deliver a method of changing travel behaviour. First, the exploratory work suggested that walking would be an appropriate mode to promote: praised for its relative ease,

with high levels of reported satisfaction, and whilst being the most accepted alternative mode from car users (compared against bus or bicycle use). Second, it became clear that with a lack of awareness over walking routes to and from campus, and experimental work indicating difficulties with identifying new routes unless experiencing a shift in context, a map that showed appropriate walking routes could be created and launched at an appropriate time to disrupt context. Third, results from the exploratory and confirmatory studies helped form the appropriate messages to encourage behaviour change. Instead of promoting the environmental benefits of changing mode, messages should promote the autonomy and hassle-free benefits of walking.

### **8.3 Study 9**

Reviewing the conclusions of previous chapters, and considering their application, the primary focus became the creation of a map advertising walking routes to the university campus. Once a map was created, I could then plan an advertisement and launch strategy informed by the previous results.

#### **8.3.1 Ethical Approval**

Approval was granted by the University of Bath Department of Psychology ethics committee, Ref: 12-119.

#### **8.3.2 Creating the Map**

Initial ideas for the walking routes to the university came from my personal experience, as well as suggestions from lead supervisor Dr Ian Walker, and examining maps of public footpaths provided by the Department of Estates. Routes were considered that were accessible (i.e. pavements, footpaths, and bridleways), scenic, direct, and provided shortcuts that may not be considered by people who only use the main roads leading to the University of Bath (primarily Bathwick Hill). To display walking routes, the free service provided by Google Maps was selected as the platform to expand upon. Google Maps offers a range of services that makes it ideal for this project. It is a free resource both for building and accessing a map, and supported by a corporation with much more advanced programming, artistic, and technical skills than any resource I could create. Including accurate maps and satellite/aerial views of Bath that people can use, routes can easily be displayed. Google Maps also offers cross-device support and is available on desktop computers, tablets, and most importantly, on smartphones. Modern phones can access the Internet using 3G networks across Bath, can display Google Maps on all key phone platforms (Apple, Android, Windows, and Blackberry), often include GPS devices that interface with Google Maps so people can pinpoint their location, and of course, are portable. Using Google Maps, the first draft of the walking routes is shown in Figure 31.



**Figure 31: First draft of walking routes to the university campus. The six routes are highlighted by different colours, and the blue-shaded area represents the university campus (Google Maps, 2014a).**

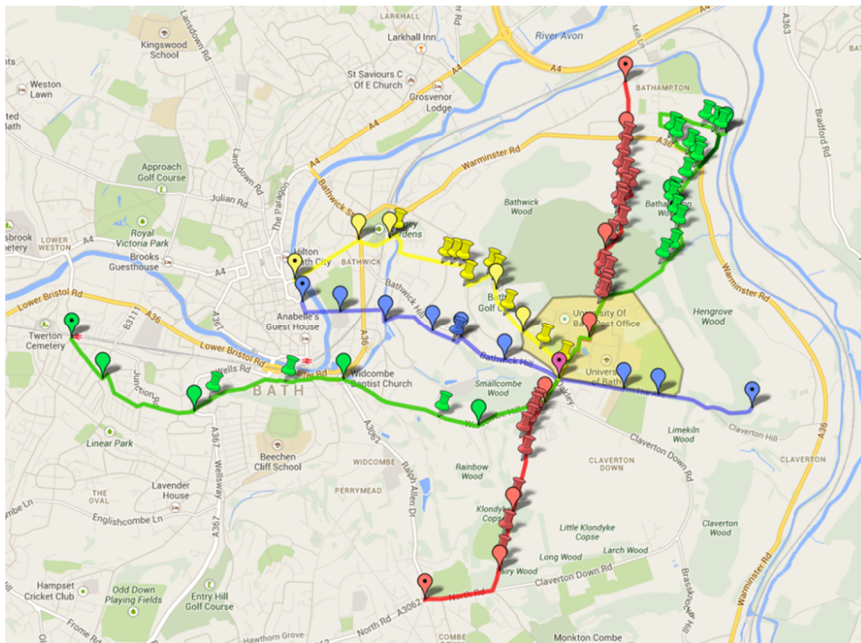
The original concept of the project was to increase walking to the university, but two factors led to a change in project scope. Firstly, given the potential applicability of the project to a wider audience, the routes could extend further than the university to include other areas of the city of Bath. There are no other cities in the UK with walking networks for scenic and transport opportunities, and this project could be valuable for all residents. Secondly, the extension of routes provides a potential opportunity to reduce the perceived distances by extending walking routes past the university. Classic perceptual illusions influence the perceived length of lines, such as the Muller-Lyer illusion<sup>20</sup>, which has been shown to influence distance perceptions on maps (Gillan, Schmidt, & Hanowski, 1999). By framing the length of routes beyond the university, this could help people consider the distance to walk as shorter by not travelling all the way to the ‘end of the line’, but only a fraction of the total distance, which may make routes more palatable.

Routes were extended to several locations around the university, including connecting the local towns of Combe Down and Bathampton. Of the 6 routes shown in Figure 31, routes were merged into a single path that extended between the two towns from North to South, and included a footpath across a golf course. With a new design, I walked each route to ensure that they were met the initial criteria: accessible, scenic, direct and shortcuts. One route (shown in yellow in Figure 31) was rejected for being extremely difficult to walk; at one point the route included a slope gradient of 25%. Walking the routes also allowed the formation of ‘landmarks’: key locations along each route to serve as guides, often at crossroads to help

<sup>20</sup> Where line A:  $\rangle\text{---}\langle$  appears longer than line B:  $\langle\text{---}\rangle$  when both lines are the same length.

path finding. Landmarks included local attractions, castles, scenic points, bridges, named locations, and canal locks. These landmarks could also give walkers a sense of progression as they traced the route, and consider the context of the route as a scenic path.

Another advantage of using Google Maps is the display of images along the routes. Google Maps offers a 'Street View' service, with panoramic views of every street, which can help people visualise the routes. With each route moving off-road, Street View isn't available, but Google Maps allows custom photos to be placed on maps. Walking each route with a camera, photographs were taken to illustrate scenic views, gates, crossroads, and each of the landmarks along the routes. These were uploaded onto the route map. The final online map is shown in Figure 32 below.



**Figure 32: Final online map of the four colour-coded walking routes across Bath. Symbols along each route host a photograph of the route at that location. (Google Maps, 2014b)**

A fundamental point for the online map was to make planning a walking route easy. By reducing uncertainty of the route, it was hoped that the first walking trip would be as stress-free as possible, encouraging further walking in the future. From the comfort of home, people could view the route, see images, and understand what the route involved; all of which could now be achieved. The next step was to create a physical presence to further enhance the routes.

### **8.3.3 Developing the project with Bath & North East Somerset Council**

With an extended project scope to include residents in Bath, contact was made with Jessica Fox-Taylor, Walking Officer at Bath & North East Somerset Council (B&NES). With a job-role that involves promotion of sustainable travel, and as a position in the local authority, Ms Fox-Taylor became heavily involved with the co-ordination and development of the project.

Discussing the implementation of the walking routes, it became clear that a physical presence was required to support the online routes. With permission granted from the local council to place signs along street furniture (e.g., lampposts and fences), the idea of using stickers to highlight the routes was developed. However, lacking any real abilities in graphic design, an additional party was required to design a cohesive brand to identify the project, and to create the stickers and signs.

### **8.3.4 Designing the “Walking Network” with Bath Spa University**

The University of Bath is focused upon science, technology, and engineering. A second university also exists nearby, Bath Spa University, who specialise in Humanities and the Arts. Through Ian Walker, contact was made with Anthony Head, a lecturer specialising in Graphic Communication at Bath Spa School of Art and Design. Discussing the project with Mr Head, and the need for graphic design skills, we offered the opportunity for Bath Spa students to establish the design profile for the project. This became a mutually beneficial deal: not only would students be able to create the design free of charge, but they would also have a recognisable client (University of Bath and B&NES) to include in their design portfolios when applying for jobs after graduation. A Design Brief outlining the concept of the project was written, with requirements for a series of stickers and branding materials, and for a stylised representation of the route map similar to the iconic London Underground map. The key to the design was to create a lasting brand that could continue after my research, and hopefully expand in the future. The brief was circulated to final-year students under Mr Head; five students<sup>21</sup> expressed an interest in the project, and formed a co-operative design team:

*“Working on the Walking Network Project acted as a very useful bridging project between finishing University and moving to the world of Design as a business”*

On June 10<sup>th</sup> 2013, the design team presented four concepts for sticker and branding designs. Combining concepts across the designs, the design team established the “Walking Network”, a visible and eye-catching brand to illustrate and promote the walking routes.

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<sup>21</sup> With credit to Gina Richards, Daryl Hoadley, Lucy Pendlebury, Lucy McArthur, and Jordan Wright





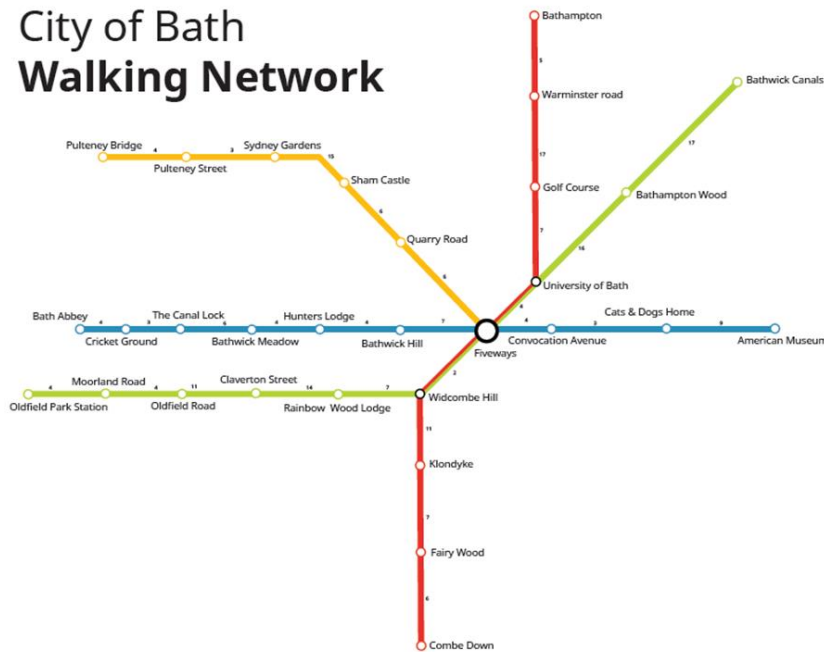
**Figure 33: Final logo design for the "Walking Network", developed by the Bath Spa design team**

The design brief called for a logo that represented an arrow that could be used in the field to highlight appropriate paths, would be recognisable from a distance, and eye-catching. As seen in Figure 33, the final logo embraced the four colours of the walking routes while clearly indicating a direction. The use of the arrow was specified, since the design brief called for circular stickers that could be easily rotated to point to appropriate routes. The Bath Spa design team came up with a new concept that incorporated two stickers; a single band that represented the colour of the route that would wrap around a lamppost and the circular sticker attached on top. With stickers designed to indicate paths going to and from the university, the band gave an eye-catching design from all directions, and allowed two stickers to be placed on the band: one marking the way to the University of Bath, and the other marking the way to the end point. A set of circular stickers were created that included a description of the route heading either towards, away, or via the university. The circular designs and coloured bands were printed as vinyl stickers, durable enough to survive cold climates and rain. Band stickers were placed along each route at regular intervals of either every third lamppost (approx. 35 metres), or whenever possible when routes passed through fields (e.g. fences). Effort was made to ensure that at every road crossing and junction, stickers would be placed to clearly demonstrate the required path. An illustration of these stickers is shown in Figure 34.



**Figure 34: Photographs demonstrating the band and circular arrow sticker designs placed along each walking route.**

In addition, a stylised representation of the total Walking Network was required. The final design is shown in Figure 35.



**Figure 35: Stylised outline of the Walking Network, inspired by the London Underground Map. Each route displays landmarks, with average walking times (minutes) between each point.**

As an additional detail to the outline map, estimated walking times between points were calculated by timing my pace (approx. 3.4 mph, or 5.5kph) as I walked each route, with times recorded between each landmark. Factoring the gradient of the hill, and the decrease in speed when walking up, the average of walking downhill and uphill were used between each landmark.

#### 8.4 Launching the Walking Network

As the first phase of a program to increase walking, and with the intention to expand and improve upon the Network in later years, it was decided that a ‘soft’ launch would be preferential. A Soft Launch can be described as an “*understated and subtle*” release of a program, without the fanfare of a ‘Grand Opening’, that highlights issues within a trial period to maximise the final launch (Friedlein, 2001, p.212). The lessons learned from this initial launch will help inform future work that may expand the Walking Network.

Inspired by results in Chapter 7, where a context change led people to re-evaluate maps, and register and use shortcuts that may previously have been missed, the soft launch was to be held during the first two weeks of the 2013/14 academic term. The benefits of context change to encourage sustainable travel has been highlighted previously (Bamberg, 2006; Verplanken et al., 2008), and with the influx of new students arriving, and previous students returning from summer vacation, the new term date presented an ideal time for launching the Walking Network.

Route-marking stickers were placed along each route one week before the start of

term (30<sup>th</sup> September). As a project funded by the Department of Estates, information on the online map was hosted on their section of the University of Bath Intranet, highlighting a link to the online map, stylised map, and a brief summary of the project. To promote autonomy, the project description included several references to the ease of walking as a stress/hassle free method of transport. Once uploaded, the Walking Network was highlighted on the intranet newsfeed, which automatically appears when staff and students access the internet on campus machines. The news-article also promoted the project, with references to autonomy included.

#### **8.4.1 The TravelWest Roadshow**

Promotion of sustainable travel is a key priority for many local councils, and in 2010 the councils of B&NES, Bristol City, North Somerset, and South Gloucestershire teamed up to create “TravelWest”. The TravelWest program is a concerted effort to develop sustainable travel across the West of England. The project typically employs measures that fall under the umbrella of ‘Smarter Choices’: a UK-wide policy effort to encourage sustainable travel, highlighted by a report published by the UK Government to promote modal change by encouraging alternatives to car use (Cairns et al., 2004). Discussing the Walking Network, Ms Fox-Taylor highlighted how the project matched current TravelWest policies:

*“The walking Network took a simple principle of on street way-finding, linked it to the digital age, and presented it in a very accessible and engaging manner. It encompasses so many of the tenets of Smarter Choices, I predict it will be referenced and replicated for years to come.”*

A key benefit of partnership with B&NES Council was the availability of additional resources. Funded by a collaborative 15-year plan to sustainable travel, TravelWest represents a range of projects and promotions, including a ‘Roadshow’ team that provide information, resources, and advice at local events. Through Ms Fox-Taylor, the Travel West Roadshow team was booked and hosted a session on the University of Bath campus on 3<sup>rd</sup> October.



**Figure 36: The TravelWest Roadshow stand promoting the Walking Network on university campus**

The TravelWest team were briefed on the Walking Network, and using a tablet computer, were able to show the online map to visitors. Once the roadshow had finished, TravelWest advisors were asked their opinions of the Walking Network:

*“It is well thought out, easy to understand and will hopefully provide other educational establishments with the inspiration to design their own”*

The Travel Team also suggested some future improvements, specifically citing a desire for more physical copies and information to hand to people, such as information flyers and pocket maps. Advisers also suggested that the launch could implement more interactive advertisements, such as competitions or case-studies of walkers. When discussing staff and students, the reported feedback on the Network was very positive:

*“There was a great deal of interest in it today and I do believe that some people we spoke to will use it . . . People really liked the chance to view the photographs along each route to help them learn more”*

From the launch of the news-item, and using the tracker on Google Maps, the online map was viewed around 330 times during the first week, building up to around 590 views by 1<sup>st</sup> December 2013, two months later.

#### **8.4.2 Wider Interest and Legacy of the Walking Network**

With the initial launch, there was a rise in interest in the Network. The use of social media became a useful method, with several people discussing the Walking Network on Twitter, and publicising the path-finding stickers:



**Figure 37: Screenshot illustrating support of the Walking Network design on social media site Twitter.com**

Alongside local efforts to increase awareness of the Network, I was invited to give a presentation on the project at the South England Business Travel Awards ceremony at Bath Guildhall on the 28<sup>th</sup> November 2013. The annual awards recognise the efforts of businesses and councils across the South of England to reduce car use, and award recognition and prizes to groups that take the most pro-active approaches to promotion of sustainable travel. I was invited to present an overview of the Network as a concept for other organisations during the proceedings, as a highlight of new methods in promoting sustainable travel.



**Figure 38: Delivering a presentation on the Walking Network at the South England Business Travel Awards**

After the presentation, several organisations expressed their interest in creating similar schemes to the Walking Network, including Bristol City Council, ARUP Consulting, the University of Bristol, and the University of the West of England (UWE). As discussed by Ms

Fox-Taylor from B&NES Council, the impact of the Walking Network has continued throughout other stakeholders:

*“The reputation of the Network has travelled far and fast in the world of Smarter Choices. I’ve sat in a variety of meetings from the Bath Cycle Forum to LSTF [Local Sustainable Transport Fund] Marketing meetings where it has been praised for its ingenuity, effectiveness and simplistic nature.”*

With strong interest in establishing similar schemes, it is hoped that the Walking Network approach will be replicated in several areas to further promote sustainable travel mode choice.

## **8.5 Discussion**

This chapter outlines the creation of the Walking Network: a series of walking routes designed to offer quick, scenic, and usable walking routes to promote sustainable travel to those who many not previously have been aware of the routes. The inspiration for the Network arose from the research undertaken during my PhD, and applies findings and suggestions from each study to formulate the design and implementation of the Network.

### **8.5.1 Using and evaluating an Action Research approach**

With time and resource constraints, coupled with the complexity of designing a randomised control group within a university-wide intervention, an alternative to conventional research design was required. It became clear that a holistic Action Research method could be used to develop, build, and evaluate the Walking Network. Described as holding a “vanguard orientation” (Reason & Bradbury, 2008a, p. 696), Action Research is predominantly focused on applying research to improve a situation. Investigations throughout this thesis have highlighted a range of automatic concepts that can be applied to encourage behaviour change, and Action Research offered a framework to apply this research, while generating new concepts and understanding for future development. Action Research is cyclical: an on-going evaluation of a project, that leads to improvements of the original idea to make a more positive change (Christ, 2010; Lewin, 1946; Maruyama, 2004; Reason & Bradbury, 2008b). The design and introduction of the Walking Network described here is the first step in the cycle. The Walking Network will likely continue past this PhD project, and be extended and evaluated to improve the resources available.

Evaluating the results of an Action Research project is an open approach; the process is often described only as “reflection” upon the actions undertaken and the lessons for future work (Greenwood & Levin, 2007; Maruyama, 2004; Stringer, 2007). A more detailed approach offered by McNiff and Whitehead (2009) describes the need to give “validity” to the claims of knowledge learnt and practices changed (p.193). Validity of Action Research is

defined by “personal validity”, where the researcher considers their own experience, and the “social validity”, where other stakeholders consider the project results (McNiff & Whitehead, 2009, p. 194). For personal validity, I feel the Walking Network represented the best possible outcome within situational constraints. The intention was to create a new approach to encourage walking as a travel mode, one that was guided by results of previous investigations described through this thesis. Despite an original desire to develop a quantitative and controlled research intervention, the integrated approach of Action Research opened up the project to a wider audience. Controlling information and withholding access to the Network would be required in a controlled trial, whereas the inclusivity of Action Research brought a wider audience to the project. Linking to the ‘social validity’, the extremely positive views of the wider audience supports the Network as a successful project. With positive results from potential users and professional behaviour change advisers, the goal of the Network to encourage behaviour change is validated. The additional support expressed by the local council, and the range of other stakeholders across the west of England gives further credence to the project design. With keen interest in developing similar projects inspired by the Walking Network, the influence of the project to encourage sustainable travel across a wider area than I originally anticipated certainly supports the original aim of enacting change. It may be possible that with interest in the project from influential stakeholders such as councils, hospitals, and universities, the project may be evaluated in more detail, and the message may spread even further beyond these applications.

### **8.5.2 Reflections on the development of the Network**

The Network was publicised as a 'soft-launch' approach, which gave the opportunity to recognise any difficulties with the Network, and learn from any difficulties when using the maps or logistical issues (Friedlein, 2001). Action Research is also a process of reflection and learning from experience. Even with the positive support from stakeholders and potential users, developing the Network for future use could likely bring large benefits, and there are some lessons learnt from this stage of the project.

The strong emphasis on using online resources encouraged interactivity and a broad availability of the resources; however, there were some calls for more physical features: TravelWest advisers mentioned that physical copies of the information, such as informative flyers and pocket maps, would provide a useful addition for people. The call for physical information invokes research findings that investigate how information displayed on computer screens compares to physical print. In experiments that compared reading passages on a screen or on printed paper, participants reading physical print seem to show greater comprehension of the text context (Mangen, Walgermo, & Brønnick, 2013), as well as greater recall of text information at a later date (Wästlund, Reinikka, Norlander, & Archer, 2005).



Interestingly, the discrepancy between screen and print was found in one experiment only when participants were given the choice of how long to spend on the information (where screen readers performed lower in comprehension), but when given a fixed time to read, conditions were comparable (Ackerman & Goldsmith, 2011). When encouraging volitional behaviour change, the concept was for people to review information at their leisure, which suggests that offering hard copies could be a more useful avenue to explore. This is not to say that the online media is ineffective – the interactivity of the maps was praised by Travel West advisers and roadshow respondents – but hard copies may facilitate the retention of information.

An important lesson learnt when designing the routes for the Walking Network was to personally walk each route, in different conditions, before finalising the routes. As described earlier, one route that was drafted according to local walking maps, but this route proved to be too challenging for a commuting option, and would likely present problems during rain and snow. Once routes were finalised, project work moved to the design of materials, including the stickers, which would provide a physical presence along each route. While the stickers were designed to be visible when placed on lampposts, I had forgotten to consider the availability of metal surfaces along routes that moved through fields and forests. In these situations, stickers were placed where possible on fences and occasional poles, but at a lower frequency than when routes travelled streets. For future work, a durable bracket or wrap could be placed around trees, which would then hold a sticker design without damaging the tree, or allowing the sticker to become loose.

Throughout the design and development of the Network, partnership with local organisations proved invaluable. Working with Bath Spa School of Design established a more professional and eye-catching design, and co-ordination with B&NES Council permitted the use of lampposts to display stickers, while organising the Travel West Roadshow to launch the campaign. The project highlighted the need for an inclusive approach to work with stakeholders who can offer many new things, and more groups may be interested. For example, at several points the Walking Network follows the Bath Skyline Walk laid out by the National Trust, a UK charity promoting conservation of natural environments. With a series of scenic walks around Bath, it may be possible to co-ordinate advertisement with the National Trust to promote the Network as a scenic route, whilst promoting the leisure-orientated Skyline Walk. Contacting local walking groups may also be helpful to bring new experience and enthusiasm to the project.

### **8.5.3 Future extensions of the Walking Network**

Building on the reflections that look back at the initial development of the Walking Network, several ideas were generated for the future of the Network, and the next ‘cycle’ of the Action



Research (Lewin, 1946). It became clear that in order to establish the Network as a valid transport option for staff and students, a stronger advertising presence is required. While the 'soft launch' provided some initial feedback, only minor promotion took place using the Roadshow and some online advertisements. Information was publicised during a time of context change to minimise previous habits and encourage information retention (Betsch et al., 2001; Verplanken, Aarts, & Van Knippenberg, 1997; Chapter 7), but alternatives to simply delivering information may be helpful. As suggested by the TravelWest advisers, running a competition to highlight the Network may be a beneficial method of promoting the Network itself, but also a means of encouraging some use of the Network. For example, the competition may involve taking a photograph of an item placed along one of the walking routes to show the participant's use of the route, or answering a question as it appears in the middle of the route. While the competition may offer a prize, the longevity of incentives to encourage sustainable behaviour change are often limited (Abrahamse, Steg, Vlek, & Rothengatter, 2005). Instead of solely promoting prizes, a competition event could include some form of team-creation, where participants can group together to form teams (possibly around university departments) to record the frequency of using the Walking Network, which would enter them into the competition. Such team-competition designs have proved incredibly popular in other areas, such as the annual 'Bike Commute Challenge' in Oregon, USA, that recently attracted over 10,500 participants and with over 1.15 million miles cycled (Noll, 2013). Walking is an activity praised for its social nature (Darker, Larkin, & French, 2007), and this should be encouraged in the Network. In a meta-analytical review, the effectiveness of social-based measures for sustainability have shown good effects when encouraging behaviour change, with additional benefits over other intervention approaches such as information or feedback methods (Abrahamse & Steg, 2013). In particular, the use of 'Block Leaders' (people who publicly champion the behaviour and encourage others) were linked to strong beneficial effects for conservation behaviour (Abrahamse & Steg, 2013), particularly ideal for a group-based competition to encourage walking.

One of the key advantages of the Walking Network project is cost effectiveness and availability. Using the free Google Map service as an online platform, routes were easily accessible by a range of devices, and supported by additional features such as Google 'Street View'. To emulate the Street View service, additional photos of the routes were hosted on the maps to illustrate their appearance: a service that proved popular with users; however, the photos were static and fixed views of only one direction. When compared to the Street View service, which offers an interactive and panoramic view of locations, the Network photos are less informative and immersive than experiencing an interactive 360° view of the location. In December 2013, Google released a new feature which may address this problem. Titled

“Photo Sphere”, the feature allows the user to generate a 360° view (similar to the Street View images) comprised of several images pieced together, and can be hosted on Google Maps. With the popularity of the static images to show walking routes, offering an interactive and panoramic view along routes would likely prove an extremely popular feature, and should be considered for upgrading the Walking Network routes.

Any improvements to the Walking Network, in line with the cyclical and reflective characteristics of Action Research, will require some evaluation (Lewin, 1946; McNiff & Whitehead, 2009). The current evaluative approach employed a form of qualitative research that collected quotes from project stakeholders to evaluate the project concepts. Results were extremely positive, and demonstrate the success of the concept for future extensions. Qualitative approaches are a powerful method when exploring new concepts (Tashakkori & Teddlie, 2009; Willig, 2008), and with the novelty of the Walking Network, qualitative measures have highlighted the broader impacts and views of the launch. Yet using qualitative responses, while giving an in-depth understanding, lack the generalisability of quantitative methods (Willig, 2008). Now that the Network is established, future work can attempt to accurately measure the impact of the project. To promote replications of the Network, publishing information on the project outcomes may help to persuade other organisations to implement similar schemes. Further consultation is needed with users of the project, and it remains to be seen how not only walking levels are influenced by the Network, but whether perceptions of walking are influenced, and if recognition of available routes increases.

## 8.6 Conclusions

This chapter describes the creation of a project to encourage walking as a sustainable travel mode: the Walking Network. A series of routes designed and promoted to encourage walking, the project was designed and implemented using an Action Research orientation, a pragmatic approach with the principle aim of enacting positive changes by applying research. Using findings reported throughout this thesis, the Walking Network incorporates a number of features that capitalised on addressing automatic concepts, such as route awareness and promoting messages of autonomy, to encourage change. Feedback from the project was extremely positive, from potential users and local stakeholders, to the interest and the potential uptake of similar projects from several large workplaces across the West of England. Noting the Action Research tenet of reflection and improvements, the Walking Network may be developed by a comprehensive launch promoting the project, updated technological links, and a detailed evaluation using quantitative measures. The Walking Network represents a novel and exploratory approach to changing behaviour, with a lot of positive support from interested parties. The next step will be to fully understand and evaluate the effectiveness of the program, and how it may be further improved.



## Chapter 9: General Discussion and Conclusions

### 9.1 Introduction

This thesis began by reviewing some of the negative effects from reliance on private car use. Problems include the close relationship between car use and obesity (Frank, Andresen, & Schmid, 2004; Jacobson, King, & Yuan, 2011), the harmful effects of transport pollutants on child asthma (Gehring et al., 2010) and other respiratory diseases (Knox, 2008), while annual congestion-related costs are expected to rise to around £22 billion by 2025 (House of Commons, 2011). On a larger scale, however, are the consequences for the environment. Transport is the second largest producer of CO<sub>2</sub> and other greenhouse emissions in the UK (DECC, 2014), mostly generated by cars and taxis (DfT, 2011b), and road transport emissions have a more harmful effect on climate change than emissions from aviation or shipping (Berntsen & Fuglestad, 2008). Encouraging a modal shift toward active travel modes (e.g., walking and cycling) can improve public health (Rabl & de Nazelle, 2012) with minimal emissions, and greater use of public transport also increases physical activity (Wener & Evans, 2007) with reduced emissions (DEFRA, 2012).

To encourage modal change, research has explored motivations behind modal choice, to target these motives for behaviour change interventions. The literature review in Chapter 2 highlighted the example of the Theory of Planned Behaviour (TPB: Ajzen, 1985, 1991): a rational-choice model that predicts that behaviour is directly informed by intentions, which in turn are created through a person's attitudes, social norms, and perceived behaviour control (which also influences behaviour directly). The TPB became the most popular framework for exploring modal choice (Anable, 2005; Bamberg, Ajzen, & Schmidt, 2003; Gardner & Abraham, 2008; Jakobsson Bergstad, 2007), but there are also calls to expand the nature of the TPB to include additional components, particularly to include automatic and non-conscious influences not accounted for by the TPB (Conner & Armitage, 1998; Sheeran, Gollwitzer, & Bargh, 2013). This thesis considered two particular sources of automatic influence in detail: habitual behaviours that are automatically performed, and the personal sensation of positivity/negativity known as affect. Habit and affect have both been found to be independent factors of the TPB (Gardner, 2009; Steg, 2005), and discussed as potentially useful concepts within modal choice (Chatterton, Coulter, Musselwhite, Lyons, & Clegg, 2009; Innocenti, Lattarulo, & Pazienza, 2013; Kenyon & Lyons, 2003). There is growing support for further investigation into habitual and affective influences (De Witte et al., 2013; Gatersleben & Steg, 2012), and by conceptualising habit and affect under the broad framework of Dual Process models (Evans & Stanovich, 2013; Strack & Deutsch, 2004), this thesis sought to explore automatic influences on travel mode choice, with the aim of developing a practical application of results. This chapter is the final section of this thesis, and

will give a description of the work undertaken, review how results may be useful for theory and practice, discuss areas for future research, and critically evaluate the thesis as a whole.

## **9.2 Summary of Work Completed**

The structure of this thesis, as outlined in Chapter 1, is comprised of five parts: Background Information; Exploratory Work; Investigative Work; Applying Results; and Conclusions. Each part describes the development of ideas throughout this thesis. The first part, Background Information, gave a detailed review of concepts discussed throughout this thesis, and a brief discussion of the mixed-method philosophy. Mixed methods research is described by Teddlie and Tashakkori (2010, p. 10) as a “cycle of research” that begins with general observations, before moving to testing of ideas, and then applying results. This structure was emulated within this thesis, and the exploratory, investigative, and applied work parts of this thesis are summarised below.

### **9.2.1 Exploratory Work (Chapters 3 and 4)**

Chapter 3 reported an exploratory qualitative study that used a Grounded Theory (Glaser, 1992; Glaser & Strauss, 1967) approach to analyse focus groups with bicyclists, car drivers, motorcyclists, bus users, and walkers. Discussions centred on carbon reduction and climate change, how transport is linked to carbon reduction, and the idea of changing travel behaviour for the environment. Analysis led to an explanatory grounded theory that demonstrated the importance of the affective need for autonomy in travel mode choice: autonomy was a source of personal satisfaction for each travel mode group, people disliked other modes for perceived loss of autonomy, and this threat of losing autonomy was a barrier to travel mode change. Through comparisons of mode user groups, a series of interesting similarities and conflicts emerged, including the different levels of satisfaction reported with modes, conflicts between general and specific environmental support, the psychological barriers to modal change, and the role of environmental policies interfering with personal choice.

With a range of topics opened by the qualitative work, an alternative exploratory approach was employed that offered a contrasting view to ‘triangulate’ a series of research topics that could be explored in more detail (Lieber & Weisner, 2010; Teddlie & Tashakkori, 2010). Described in Chapter 4, a large-scale survey of university staff and students was designed with a selection of exploratory psychological scales. The survey included a replication of a previous investigation that modelled the multi-factor complexity of travel mode affective appraisals (Gatersleben, 2007). Comparisons suggested that active mode users felt more positive, but defined by either excitement (bicyclists) or relaxation (walkers), while car users were surprisingly neutral; a finding possible linked to the norm and default nature of car use in the UK. Noting uncertainty in focus group responses discussing which modes were

more automatic, the first comparative measure of habit strength was included. Comparisons of habit strength (Verplanken & Orbell, 2003) indicated that active mode users held stronger habits, a result that may be linked to more positive affective appraisals, with potential application for habit theory. The survey was also the first to compare different travel mode groups for their general environmental worldviews (Dunlap, Van Liere, Mertig, & Jones, 2000), and despite popular stereotypes of bicyclists and non-car users as ‘green’ (Anable, 2005; Daley & Rissel, 2011; Gatersleben & Haddad, 2010), no substantial differences were found between groups. Linking the reported benefits of affective appraisals of the commute with improved mental states, the survey also compared user groups for their mental well-being (Tennant et al., 2007), but with no significant differences found; suggesting the need for more detailed understanding of possible links between active travel and mental well-being.

### **9.2.2 Investigative Work (Chapters 5, 6, and 7)**

The exploratory work generated a huge amount of possible research directions: this thesis could have focused purely on the differences in affective appraisal, or why habit strength was larger in active travel mode users. But with the intention of remaining exploratory, and to investigate how automatic influences could inform alternatives to rational-choice concepts, the roles of affect and habit were investigated. With this desire to explore, and not finely detail a particular research topic, a range of investigations were proposed.

In Chapter 5, the replication of the Comprehensive Action Determination Model (CADM: Klöckner & Blöbaum, 2010) is described. Considering the exploratory first survey, the second university travel survey employed a theoretically-guided approach, and evaluated the CADM as a promising model that combines the rational processes of the Theory of Planned Behaviour (Ajzen, 1985, 1991) and the Norm Activation Model (Schwartz, 1977; Schwartz & Howard, 1981), while including the automaticity of habitual processes (Verplanken & Orbell, 2003). Results from the focus groups suggested a range of different views between modes, and survey work in Chapter 4 identified differences in habit strength; with so many possible influences on behaviour discussed, the CADM presented an excellent opportunity to compare group differences on several factors, while exploring the divide between automatic and rational processes. However, the research process uncovered three main difficulties that complicated results. First, the survey questions may not have been specific enough for each of the travel mode options, which could explain the lack of correlation found between intentions and behaviour. Second, the replication of the model involved Structural Equation Modelling (SEM), a statistical approach that appears to have a vast range of conflicting views and procedural uncertainty, creating confusion when interpreting results. Third, the CADM (Klöckner & Blöbaum, 2010) seems inconsistently defined; across five published reports, model pathways change, and scales are

included/excluded without consistent theoretical basis and without comment. With uncertainty on the analysis and model in question, results suggest that future work is needed to specify an improved or new model: one that demonstrates the temporal influence of habits across attitudes and intentions: possibly by specifying features that allow dual-process concepts to compete (Evans, 2009; Stanovich, 2011) when modelling behaviour.

After the complexity of SEM, Chapter 6 focused on a smaller project inspired by contrasting environmental views. Chapter 4 survey analysis suggested no differences in environmental worldviews between mode groups. Yet the Chapter 3 focus groups reported diverse environmental views: active mode users were strongly pro-environmental, while other user-groups gave explicit support but were highly critical of any potential changes to actively reduce emissions (often citing personal autonomy infringements). Some authors (Ewert & Galloway, 2009; Oerke & Bogner, 2011) have suggested that environmental concern may be open to forms of social desirability bias (Paulhus, 1991), which may account for contrasting results between surveys and natural dialogue (Farquhar & Das, 1999). In response, an implicit measure was proposed to capture automatic, rather than reasoned, assessments (De Houwer, Teige-Mocigemba, Spruyt, & Moors, 2009), which can overcome some biases (Greenwald, Poehlman, Uhlman, & Banaji, 2009; Nosek, Greenwald, & Banaji, 2007). A new method was designed using the Implicit Association Task (IAT: Greenwald, McGhee, & Schwartz, 1998), and applying the value orientation measure for Egoistic and Biospheric values (De Groot & Steg, 2007, 2008). After ensuring balanced and representative stimuli, the Environment IAT was applied across three independent samples, and evaluated differences between members of environmental organisations and the general public. Results showed consistent and clear links between the new Environment IAT and explicit measurements, medium to large differences between-groups, and the Environment IAT was a significant predictor of environmentalist status even after controlling for explicit environmental worldviews and value orientations. Unfortunately, the Environment IAT was not able to detect any differences between active mode users and car users, and neither did explicit value orientations. It would seem that despite stereotypes of environmentally-focused active mode users (Daley & Rissel, 2011; Gatersleben & Haddad, 2010), and that some active mode users feel more strongly about environmental issues than some car users (Chapter 3), groups may not systematically differ in their reasoned or automatic preferences.

Chapter 7 continued using experimental tasks, and investigated the influence of routines on a path-finding simulation. Focus group responses indicated that some non-active mode users found it difficult to consider the route they would take to walk to the university after routinely driving or using the bus along the same fixed routes. Routines can develop into habitual processes (Wood & Neal, 2007), which limit the amount of information sought or

required to make decisions (Aarts, Verplanken, & van Knippenberg, 1997; Verplanken, Aarts, & Van Knippenberg, 1997). To investigate whether routine path selection may blind a person to alternatives, a computer game was programmed to simulate a route-finding task across a fictional town, with three varying levels of using a 'car' or 'bicycle' avatar to select routes. The map also featured a 'park' that could act as a shortcut when using the bicycle. The hypothesis was that by using the car avatar, a road-only routine would be created, that would hinder use of the park shortcut when using the bicycle avatar. Results showed clear differences, but actually the opposite of the hypothesis: increased use of the car, prior to the bicycle, led to greater use of the park shortcut. A second study compared frequent bicyclists with the original sample (mainly car users), and found that the regular bicyclists were more likely to use the park shortcut. The experiment results may be explained by the break in context (changing travel mode) facilitating incrementally stronger consideration of information (bicycle can use the park) that led to greater use of the shortcut when available, and that prior knowledge can influence task performance (shown by the bicyclist sample). A surprising result, the experiment indicates the importance of breaking routines when encouraging change, and the influence of routines to impede use of available information.

### **9.2.3 Application of Research (Chapter 8)**

Chapter 8 applied the findings within this thesis into a useable project, and using an Action Research framework, created the UK's first Walking Network: a series of scenic and time-saving walking routes using online and physical signage. The project applied a number of findings: walking was selected as an accessible and enjoyable method (Chapters 3 & 4); a map was created to advertise walking routes not previously considered (Chapters 3 & 7); environmental benefit messages were avoided as ineffectually linked to mode choice (Chapters 4 & 6); with messages of autonomy and control (Chapter 3) used to promote the project. Action Research is an approach that promotes an application of research to address problems (Lewin, 1946), while generating a feedback system to improve and enhance the project undertaken (Maruyama, 2004; Reason & Bradbury, 2008). As my final project, the Walking Network will be expanded and further evaluated by future PhD students funded by the university Department of Estates as part of on-going work to promote sustainable travel.

### **9.3 Why are the findings of this thesis useful?**

After summarising the research undertaken, we can now consider the implications of the studies for theoretical, and for applied, work in modal change. Each chapter included a specific discussion of results, while this section gives an integrative review that combines results from across the thesis.



### **9.3.1 Comparisons between several travel mode user groups**

Both exploratory studies, using qualitative (Chapter 3) or quantitative (Chapter 4) methods, compared several travel mode user groups. Multiple group comparisons appear to be the exception within travel mode choice research: predominantly focusing on car user's views and characteristics (Anable, 2005; Gardner & Abraham, 2007, 2008). By directly contrasting several user groups, clear differences were found across a range of topics not previously reported: contrasts of excitement in discussions of satisfaction, acceptability of environmental action, or perceived autonomy in Chapter 3, to differences in habit strength, affective appraisals, and even the notable lack of differences in environmental worldviews in Chapter 4. The complexity of travel mode choice motivations became evident through these comparisons, generating a range of new research enquiries by contrasting high-level group differences for more detailed investigation in later studies. Although in Chapter 5 the comparisons of pathways within the CADM (Klöckner & Blöbaum, 2010) found no substantial group differences, a priori group differences suggest a range of theoretically interesting results for future investigation (see section 9.4 of this chapter). To better understand pathways behind reducing car use, multiple group comparison offers an integrated view of mode choice decision-making that opens new discussions not available when focusing solely on car users' reports. Comparison work within this thesis demonstrates a range of novel results and research topics within travel mode choice, and I hope the results encourage future researchers to expand their inquiries beyond focusing solely on car users.

### **9.3.2 Importance and identification of affect-based influences**

Affect was defined in Chapter 2 as an automatic sensation, which can be understood as a mixture of positive/negative valance, and high/low activation (Russell, 2003; Russell & Barrett, 1999). Affect is a fundamental component of cognition and behaviour that influences our emotions (Baumeister, DeWall, Vohs, & Alquist, 2010), attitudes (Huijts, Molin, & Steg, 2012), and motivations (Aarts, Custers, & Veltkamp, 2008). The automaticity of affect presents difficulties for reasoned models of behaviour, such as the TPB, because while it is theorised that affect is a precursor to attitudes and thus included in models (Ajzen & Fishbein, 2005), previous evidence shows affect (particularly anticipated regret) is an independent influence on behaviour (Rivis, Sheeran, & Armitage, 2009; Sandberg & Conner, 2008). Positive affective responses have been previously identified as important for car users (Steg, Vlek, & Slotegraaf, 2001) and can be a stronger predictor of car use than instrumental or TPB motivations (Steg, 2005).

With limited research on affective experiences when using alternatives to car use, this thesis details the first qualitative discussion of affective influences across several travel mode choices. The exploratory qualitative work (Chapter 3) uniquely identified that across the

range of travel mode choices, the importance of autonomy was consistently found in all user groups: autonomy delivered great satisfaction when present, but when unavailable, caused serious discomfort. Qualitative reports of car use motivation have similarly reported the desire for control and autonomy (Chatterton et al., 2009; Gardner & Abraham, 2007; Mann & Abraham, 2006), but this focus group work is the first to illustrate the importance of autonomy across all considered modes. The fear of losing autonomy was perhaps the strongest finding in the qualitative work, and raises questions for how travel mode interventions can alleviate concerns, especially if these concerns may not be reported in conventional survey work (Steg et al., 2001). Anticipated regret has been identified as a strong predictor of behaviour in meta-analytical reviews (Rivis et al., 2009; Sandberg & Conner, 2008), which can lead to resistance to behaviour change (Anderson, 2003; Mellers & McGraw, 2001). By identifying the source of anticipated regret, this thesis opens new pathways to improve behaviour change interventions by alleviating concerns of losing autonomy. Several options for addressing anticipated regret of losing autonomy are highlighted, including infrastructure developments of live-update bus timetable systems, that have been effective at reducing user's uncertainty and perceived loss of autonomy (SAIC, 2003; Schweiger, 2003).

Alternatively, the autonomy experienced by other users, such as bicyclists and walkers, could be promoted to car users, alongside other affective experiences. Survey work in Chapter 4 replicated previous work identifying affective appraisals by travel mode (Gatersleben, 2007), and though largely supportive of previous results, the current affect-based results were more consistent with the Core Affect model (Russell, 2003), by identifying the key features of valence and activation. Applying the core affect to different modes indicated a surprisingly neutral response from car users. Even after exploring the multi-faceted construct of affective experience, car users remained, at best, weakly committed to any affect-based experience of their commute. Of additional interest is the positive experience reported by bicyclists and walkers while favouring either excitement, or relaxation, respectively. If interventions address anticipated regret of behaviour change by highlighting the autonomy felt by active mode users, messages may be further tailored to those who would prefer either excitement or relaxation, to create more suitable positive affective responses.

The relationship between affective responses and mode choice was further explored in the relationship towards environmental views. Using the Implicit Association Task (IAT; Greenwald et al., 1998) and applying opposing egoistic and biospheric values as stimuli (De Groot & Steg, 2007, 2008), the affective, automatic, responses to environmental concern were compared between car and active mode users. No differences in implicit or explicit environmental values were found between mode user groups, suggesting that appeals to

environmental concern would likely be ineffective, given the lack of apparent environmental motivation from active mode users. Results support previous work that using environmental appeals for modal change is ineffective, and may actually increase resistance and reduce environmental concern (Tertoolen, van Kreveld, & Verstraten, 1998), and that any link between environmental concern and modal choice is weak at best (Gardner & Abraham, 2008; Steg & Vlek, 2009). This thesis expands this to demonstrate that environmental values, both implicit and explicit, are not substantially related to travel mode choice.

However, a positive result was the development of the Environment IAT. Previous implicit environmental measures (Beattie & Sale, 2009) lack validity, or have concerns about biased stimuli (Schultz, Shriver, Tabanico, & Khazian, 2004; Verges & Duffy, 2010). Using correlations with validated measures, observing differences between environmentalists and non-environmentalists, and as a successful predictor of environmentalist status even after controlling for explicit measures, the Environment IAT is the first validated measure of implicit preferences for environmental issues. The new measure opens a wealth of new areas for exploration, for example; exploring views of climate change sceptics when faced with climate change literature (Corner, Whitmarsh, & Xenias, 2012), predicting environmental behaviours, or as a measure that minimises social desirability biases (Paulhus, 1991). Additionally, the Environment IAT is the first measure to base stimuli upon personal values, rather than conventional objects or social groups (Greenwald et al., 2009). Several difficulties with implicit measures of values have been raised (Maio, 2010), and while the developed method may not be considered to measure values, but rather preferences towards values, the results appear successful, opening several new areas of study for automatic processes of environmental views, or use of value constructs in implicit tasks.

### **9.3.3 Influences of habitual and routine processes**

In Chapter 2, habits were conceptualised as learned automatic responses that develop in stable contexts (Verplanken & Wood, 2006; Wood & Neal, 2007). Habits are defined independently of repetition, but are characterised by their automaticity (Ajzen, 2002; Verplanken, 2006), with several implications for behaviour. As car use habit strength increases, a person's conscious intentions to not use the car become progressively less predictive of actual car behaviour (Gardner, 2009). Stronger travel mode habits can also influence information searches to require less information to make a decision (Aarts et al., 1997; Verplanken et al., 1997), can reduce the influence of acting on environmental values (Verplanken, Walker, Davis, & Jurasek, 2008), and can skew expected and remembered satisfaction for using alternative modes (Pedersen, Friman, & Kristensson, 2011a, 2011b). But despite their influence on travel behaviour, habits are under-represented in travel research, and more work is required (De Witte et al., 2013).

To explore habit strength, the qualitative discussions in Chapter 3 indicated a perceived uncertainty for whether certain travel modes were more habitually performed than others. Car habit has been mentioned by other qualitative work (Beirao & Cabral, 2007; Chatterton et al., 2009), but with limited discussion. Using a multi-group approach, the current analysis indicated the large suspicion that car users' habit strength was linked to other "barriers" to modal change; which may reflect negatively-biased predicted satisfaction with other modes (Pedersen et al., 2011a). Chatterton et al. (2009) viewed car user's habits as preventing car users from considering other modes. The current analysis found some consideration by car users of other modes, before they rejected them, demanded incentives, and created an identity of a group under attack. Resistance to modal change has been previously noted (Tertoolen et al., 1998). Applying a qualitative approach, this thesis advances our understanding of resistance to modal change: identifying the nature of this resistance, and alongside the anticipated loss of autonomy, the demands for incentives and bunkering down that need to be considered for habitual behaviours.

While car use was seen as habitual, the automaticity of using different travel modes was investigated in the Chapter 4 survey analysis, indicating that active mode users had stronger habits than car or bus users. With previous suggestions that active modes require less cognitive effort than car users (Gatersleben & Uzzell, 2007), this thesis is the first to demonstrate the stronger habitual behaviours of active mode users when comparing modes travelling to the same location. Controlling for staff/student status to remove demographic influences, measuring people travelling to the same location to control for habit goal complexities (Wood & Neal, 2007), and removing a measure of identity to prevent bias (Gardner, de Bruijn, & Lally, 2011), the underlying pattern of imbalanced habit strength likely reflects a strong link to modal choice. With stronger habit in active mode users, who were also observed to have more positive affective appraisals, results may support the idea that habit strength is enhanced by affect as *motivated* habit (Wood & Neal, 2007). An exploratory finding, it is hoped that the first contrast of habit strength found in this thesis may be replicated, and may form the basis for understanding habit development.

Cognitive influences of habit were also emulated in the investigative work, with the creation of a new game method exploring routinisation in Chapter 7. Routines are related to habits, but are not necessarily automatic (Betsch, Fiedler, & Brinkmann, 1998; Betsch, Haberstroh, Glöckner, Haar, & Fiedler, 2001), and offer an insight into how habitual processes influence cognition. In the game, context changes were linked to greater use of available information (the shortcut), supporting the habit discontinuity hypothesis (Verplanken et al., 2008), as well as previous work that context change promotes greater consideration of travel mode choices (Eriksson, Garvill, & Nordlund, 2008), and greater use

of available information (Chorus, Molin, & van Wee, 2006). A complimentary result to research suggesting that habitual routines require less information for decision making (Aarts et al., 1997; Verplanken et al., 1997), results also suggest routines can ‘blind’ people to available information. Overall, the novel game approach demonstrated strong effects, using a small number of trials, and with minimal intervention or instruction, suggesting that it may tap into strong psychological effects (Prentice & Miller, 1992). By defining how habitual behaviours may resist modal change, and the potential for habits to influence information searches, this thesis expands our knowledge of habitual influences. But also by identifying habit differences among travel mode groups, this thesis provides new insight into how habits may develop in strength.

#### **9.3.4 The importance of automatic processes**

There is a case for including habit and affect in conventional models of behaviour (Conner & Armitage, 1998; Sheeran et al., 2013), and for their consideration in travel mode choice (Chatterton et al., 2009; Innocenti et al., 2013; Kenyon & Lyons, 2003). This thesis adds additional support for considering automatic concepts in travel mode choice. Dual Process accounts of reasoning, discussed throughout this thesis as a broad theoretical framework, contrasts automatic against reasoned cognition, and each influences behaviour (Evans & Stanovich, 2013). In several studies, results have been used to demonstrate, or apply, implications of dual process accounts. In Chapter 6, automatic preferences toward Biospheric values, measured by the IAT (Greenwald et al., 1998), were a predictor of environmentalist status even after controlling for explicit measures of concern. Explicit value orientation measures, reflecting Type 2 reasoned views (Smith & Collins, 2009), were a stronger predictor of behaviour, though the additional variance explained by automatic preferences gives support to the use of Type 1 measures. The routinisation game in Chapter 7 supports developing models of dual process modes; such as Stanovich’s (2011) tripartite model where context change facilitated ‘decoupling’ to allow consideration of the shortcut. Chapter 7 also challenges the RUN/JUMP model of dual-process reasoning (Betsch & Held, 2012) by not requiring a task failure to induce a change in strategy. Combining affect and habitual Type 1 processes was theorised in the Chapter 4 survey analysis, further supporting the concept that habits may be additionally driven by positive affective experiences (Phillips & Chapman, 2012; Wood & Neal, 2007). The integration of Type 1 and Type 2 processes proposed by the CADM (Klößner & Blöbaum, 2010) was challenged in Chapter 5, noting the limited ability of habitual effects as an individual influence on behaviour, instead suggesting inclusion of multi-level strength approaches (e.g., de Bruijn et al., 2007) or implementing combined models of dual-process modes (Evans, 2009; Stanovich, 2011). Importantly, this thesis also shows how Type 1 and 2 processes may be applied to encourage sustainable travel. The

Walking Network described in Chapter 8 implemented research findings: identifying appropriate affect-based messages of autonomy, and to deliver appropriate information (walking route maps) at an appropriate time of context change for improved recognition of route options. As a broad theory, evidence for dual processes is built through a range of studies (Evans & Stanovich, 2013), and this thesis identifies dual process characteristics in travel mode choice, supporting the case for their inclusion in modal choice research.

#### **9.4 Areas for future research**

With two exploratory studies described in this thesis, there was a huge range of research inquires open for potential exploration. Constrained by time, resources, and the word-count of this thesis, a handful of topics were chosen that could be clearly answerable, relevant, and interesting to the field. This unfortunately neglected a number of potential studies, some of which are discussed below.

##### **9.4.1 Future Habit-based work**

Chapter 4 described the first comparison of habit strength across modes, demonstrating that active mode users enact their behaviour more automatically than other modes. Lally, van Jaarsveld, Potts, & Wardle (2010) measured the formation of automaticity for behaviours such as drinking water, or performing sit-up exercises. Their results indicated a wide range of timeframes for behaviour to become automatic, suggesting habit formation curves were unique to individual participants (Lally et al., 2010). Defining how individual habit growth curves develop is the next challenge, and the current results that show active mode users have stronger habits may play a role. With knowledge that travelling to the same location, with the same objective, is linked to stronger habit strength for bicyclists and walkers, the survey analysis is a potential starting point to define how habit strength may differ. For example, future research could take a longitudinal view of measuring the formation of habit strength in a new circumstance (e.g. new staff or students at the university), and observe whether positive affective experience moderates the growth of habit to create a motivated habit (Wood & Neal, 2007), as suggested in Chapter 4, and by other researchers (Phillips & Chapman, 2012).

Results from Chapter 7 suggest that the routinisation game method, with an exploration-based approach, is worth exploring in future research. Clear effects were found using only a minimal intervention and small number of repetitions, suggesting that the game taps into a strong psychological effect (Prentice & Miller, 1992). A novel approach, further work is needed to explore and define the properties of the test, including variations of the number of repetitions used, changing the avatars used (e.g., including an avatar of a person walking), and increasing variation in the use of maps and required routes for planning. Additionally, the routinisation game could be used as an investigative tool for effects of

habitual mode choices. Just as previous work demonstrated that strong bicycle habits were linked to reduced need for information to make decisions (Aarts et al., 1997; Verplanken et al., 1997), the routinisation game could explore how habit influences routine choice. The second study within Chapter 7 demonstrated that regular cyclists were more likely to use the available shortcut, but a systematic investigation using habit strength could provide more information on how habits influence cognition.

#### **9.4.2 Future Affect-based work**

In Chapter 3 focus group discussions, the perception of autonomy was a clear source of positive, but also negative, affective appraisals of the daily commute. Recognised as an important characteristic of car use (Chatterton et al., 2009; Mann & Abraham, 2006; Steg, 2005), with some indication of importance in bicyclists, pedestrians, and bus users (Anable & Gatersleben, 2005), the role of autonomy requires more consideration. Survey analysis of Chapter 4 clarified how modes differed on affective appraisals, and discussed the development of the Satisfaction with Travel Scale (STS: Ettema et al., 2011) as a general measure of travel satisfaction, with increasing support (Friman, Fujii, Ettema, Gärling, & Olsson, 2013). Future work may clarify how general affective appraisals measured by the STS relate to perceived autonomy – whether there is a direct positive link, whether autonomy can be measured as an independent factor, and whether perceived autonomy moderates experienced satisfaction.

An alternative area of affective appraisal, the Environment IAT discussed in Chapter 6 has a potentially wide range of potential use and methodological investigation. As with the Chapter 7 routinisation game, the new method of contrasting biospheric and egoistic values (De Groot & Steg, 2007, 2008) to measure implicit preferences requires further investigation to establish the validity of the measure. Future work could recruit new samples to evaluate group differences, such as using right-wing political party voters who are more likely to have stronger egoistic than biospheric values (Piurko, Schwartz, & Davidov, 2011), or explore other pro-environmental behaviours, such as acceptance of sustainable policies (Steg, De Groot, Dreijerink, Abrahamse, & Siero, 2011). Hopefully further validation of the Environment IAT can be obtained, which would facilitate research into automatic personal views of environmental topics. For example, Corner, Whitmarsh, and Xenias (2012) investigated climate change sceptics' views after receiving various information sources supporting or denying climate change; research that may benefit from measuring automatic preferences, as well as explicit preferences. Lastly, the environment IAT presents the first use of stimuli based upon personal values, and may be the first implicit measure of values (Maio, 2010). Using the contrast of egoistic and biospheric values based upon the framework proposed by Schwartz (1992, 1994), other diametrically opposed values may be applied;

values such as Freedom/Security, or Hedonism/Benevolence may be explored using implicit methods for the first time.

#### **9.4.3 Future application of results**

The development of the Walking Network in Chapter 8, based around the findings of this thesis, encourages more work to evaluate and refine the concept. Using a soft launch approach as an initial test of the network, the project received positive praise from stakeholders and interested parties, with interest in creating similar schemes in the local area. The next step is to explore what concepts work in practice, and whether the Network is an effective method of encouraging sustainable travel. Using autonomy-themed messages to promote positive affect should be investigated; appeals that used biospheric values elicits greater positivity and behaviour change than egoistic values (Bolderdijk, Steg, Geller, Lehman, & Postmes, 2013), and framing messages for autonomy should be investigated in a similar manner. Similarly, the provision of walking route information during context changes could be evaluated: experimental approaches could investigate if providing information at a time of context change (e.g., students returning to university for their second year) encourages use and retention of information, and whether the walking network routes are linked to greater use of the routes, rather than only providing encouragement to walk. The qualitative approach used to evaluate the creation of the Walking Network is an opportunity to reflect and consider the project as a whole (Lewin, 1946; McNiff & Whitehead, 2009), but the next challenge will be to empirically demonstrate the impact of the project. Qualitative methods lack generalisability (Willig, 2008), and quantitative approaches could give a value to the project that not only guides future development of the Network, but inform interested parties of expected effects when considering similar schemes.

#### **9.5 What could be improved?**

Each chapter offered a critique of the successes and limitations of methods employed, but there are some general factors throughout this thesis that are worth consideration. The exploratory research (Chapters 3 and 4) sampled staff and students from the University of Bath. This approach offered a large sample of respondents for the exploratory survey, but also a broad mix of travel mode groups that travelled to the same location, which assisted direct comparisons of views between groups in the qualitative work. Using respondents who study or work at the University does, however, narrow the generalisability of results, and it is likely that the population attending the university may be different than other populations. Considering the general UK population, the socio-economic status for students and staff is likely different to the national average. This may be particularly important given that socio-economic status is linked to a range of transport views and behaviours: car use is seen as more



attractive and enjoyable for lower socio-economic groups, and bicycling is viewed more positively by higher socio-economic groups (DfT, 2011a). Beyond the UK population, cultural differences may highlight a number of contrasts that could challenge some of the exploratory results. For example, 31.2% of people in the Netherlands use the bicycle as their main mode of transport, compared to only 2.2% of British people (Eurobarometer, 2011). Using a Dutch sample, it would be interesting to observe if there are similar concerns around car users having 'psychological barriers' to change, as suggested in Chapter 3, or if the norm of bicycle use is linked to lower reported affective evaluations, as suggested for the norm of British car users in Chapter 4. The exploratory work also suggested a range of ideas that inspired the investigative research in Chapters 5, 6, and 7. Increasing the variety of samples, or defining more specific samples through segmentation (see Anable, 2005), could evaluate the theoretical explanations offered in earlier chapters, but also spur new investigative options not considered in this thesis.

The location of the University of Bath also may influence the work within this thesis. Shown in the topographical map of Bath in Chapter 8, the university is located at the top of a hill; an issue frequently referenced by participants travelling to campus. In Chapter 3, participants discussed the perception of the hill as a barrier to active modes, and that cyclists would be “crazy” to cycle up it. In the 2012/13 Travel Survey that provided data for Chapter 5, conventional travel survey questions highlighted how bus or car users cited “The hill” as a motive for their travel mode. The perception of the terrain required consideration when promoting behaviour change, and so the Walking Network attempted to counteract these perceptions by encouraging a down-hill journey as the first trip, and selecting routes that avoided extremely steep sections. Geography may influence travel mode options, which should be considered when applying the current results to other (possibly flatter) locations, but the perception of the hill may also raise future research. In the Chapter 3 Focus Groups, one participant briefly mentioned that in Edinburgh University, there was a culture that encouraged walking to campus, even with a hill. The culture surrounding a travel mode may influence behaviour, possibly linked to the terrain, but also the travel mode itself. As an example, the perception of active modes as the relaxation found in walking, or speed and excitement within cycling, may link to expected gender roles that could influence travel mode decisions. Further work that explores the pre-held perceptions of travel choices, and the situational or social context of these modes, could offer valuable new insights for assisting behaviour change programs.

Using online recruitment for the Environment IAT and Mental-Set studies (Chapters 6 and 7) proved to be incredibly useful. Online recruitment has become increasingly popular for social sciences: offering increased participation and a wider spread of respondents with

comparable validity to conventional laboratory samples (Casler, Bickel, & Hackett, 2013; Chandler, Paolacci, & Mueller, 2013; Goodman, Cryder, & Cheema, 2013). Hosting studies online was also cost-effective: by offering personalised feedback and advertising studies as 'games', large samples were recruited without requiring monetary incentives. Feedback from forums used to advertise the studies did indicate some complications that may be improved for future work. The routinisation game (Chapter 7) was treated with some suspicion since the program had to be downloaded: some online commentators were suspicious that the program was a computer virus, which prevented them (and possibly others after reading their comments) from participating. Hosting the game within an internet browser would likely increase participation rates, reducing the need to download executable files and making the process of taking-part easier. Similarly, the Environment IAT (Chapter 6) used an online survey paired with the online IAT hosted elsewhere, and participants had to invent a personalised word that matched their survey response with the IAT. Combining all aspects of the study into a single procedure would reduce confusion, and future work may develop HTML or Javascript code to allow a complete procedure in one environment.

This thesis describes studies that successfully explored implications of modal choice, including differences in affective appraisals (Chapter 4) and performance on routinisation games (Chapter 7). However some explorations had more limited success when exploring travel mode choice; the absence of a link from intentions to behaviour when modelling mode choice (Chapter 5), and the lack of differences on environmental values (Chapter 6). Although these may be due to actual lack of differences between modes, results also highlight a deficit in systematic measures of travel mode choice. The wide variation in how modal choice is measured has been critiqued by other researchers: Graham-Rowe et al. (2011) were unable to meta-analyse the effectiveness of several car use interventions because the range of measures included car use mileage, or weekly/daily frequency, or time spent in the car, or proportion of car use over other modes. If there were a validated and reliable measure of modal choice, that was the accepted standard within transport research, the work within this thesis would likely benefit. Even using the mix of travel mode choice measures, this thesis highlights several successful results, but increased validity of mode choice measures would strengthen the interpretation and validity of results.

## 9.6 Final Remarks

In summary, the work in this thesis provides several new insights of modal choice motivation, as well as theoretical implications for models of behaviour. Two original and successful experimental approaches are proposed: exploring the affective and implicit links to environmental values, and for investigating routine decision making using an open-exploration approach. The work in this thesis also highlights how the results may be applied,

and describes the creation of the first Walking Network; an approach that has attracted considerable attention for use in other locations to promote sustainable travel. As exploratory work, I am aware that more questions have been raised than answers. Yet by highlighting several new areas and options, while demonstrating how results may be applied, I hope to have positively added to the field of modal choice research, and ideally, provided new directions and methods for future research. The next challenge is to define these concepts, and to continue research in the developing area of automaticity in modal choice. While decisions may sometimes be consciously assessed and rationalised, the importance of automatic processes in the formation of behaviour is worth consideration when promoting healthy and sustainable travel mode choices.

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## **Chapter 11: Appendices**

To conserve space, and to accommodate the inclusion of computer files to demonstrate the work described in Chapter 7, the appendices to this thesis are stored on a CD-R attached to this thesis. If this CD-R is unavailable, copies of the appendices can be requested by emailing [G.O.Thomas@bath.ac.uk](mailto:G.O.Thomas@bath.ac.uk).

### **11.1 List of Appendices**

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